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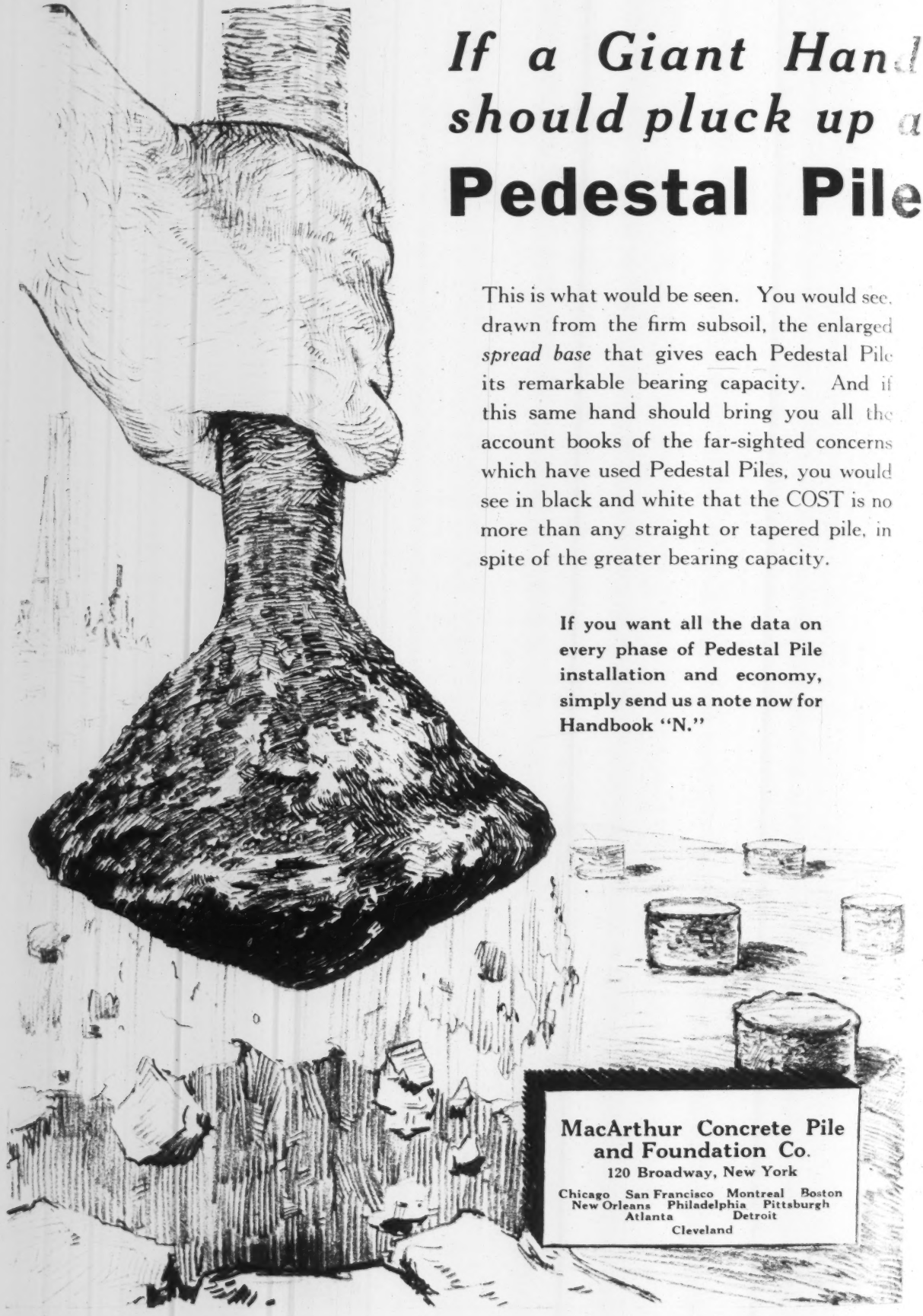

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Five Organizations Build Vast Steel-Plant Extension

Forces of Contractors and Those of Company Are Coördinated on Railway Relocation

And on Mill, Furnace and Oven Additions at Sparrows Point, Md., To Cost Many Millions

CAPACITY OF COKE PLANT TO BE TRIPLED

FIVE separate organizations, two of them under the control of the Bethlehem Steel Co. and the other three those of contractors, are working together, using a common railroad system and material supply in constructing extensions to the plant of that company at Sparrows Point, Md., the cost of which will run well into the millions. The improvements under way, part of a construction program to be completed eventually which will approximately triple the capacity of the plant, involve the construction of massive concrete and pile foundations for new mills, furnaces and related buildings, which work is divided between two of these contractors: the relocation of much of the railway system of the plant, requiring a large fill on the north side of the property, which is being handled by the third contractor; the erection of furnaces, steel and brick superstructures and the installation of machinery, which are being handled by the Bethlehem Steel Co. and the Bethlehem Steel Bridge Corporation. The work is so scattered over the site, which is a rough square one-half mile on a side, that there is plenty of room for handling modern construction equipment and storing materials.

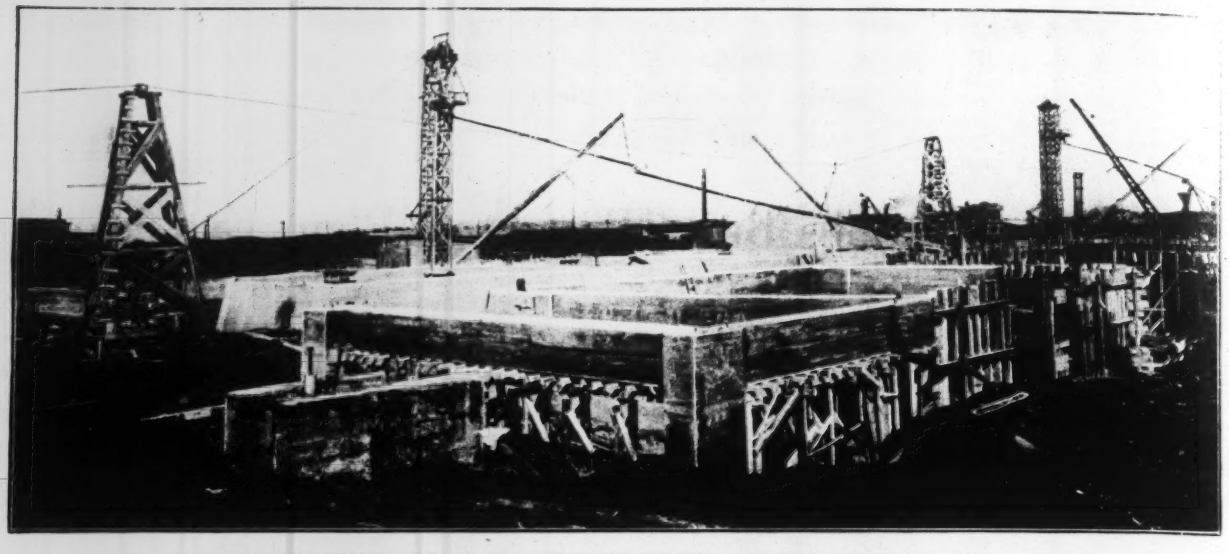
Work Falls Into Natural Divisions

The work at present under way includes two new plate mills, a new blooming mill, a gas-electric generator station of 15,000-kw. capacity, which will light the steel plant and the company's town, extensions doubling the capacity of the two gas blowing-engine plants, two new blast furnaces, a new openhearth steel plant, 240 new coke ovens, tripling the capacity of the present plant, a new railroad yard one-half mile in length at the north side of the plant and the relocation of tracks in other sections of the plant. The coke ovens are being built by the H. Koppers Co., which also constructed the existing batteries. The other concrete and foundation work is under the direction of the Dravo Contracting Co., while most of the railroad construction is being undertaken by H. S. Kerbaugh, Inc. All the structural steelwork required for the extensions is being fabricated and erected by the Bethlehem Steel Bridge Corporation, while the local office of the Bethlehem Steel Co. is in charge of all operations and will carry out with its own forces the brickwork, machinery installation and other construction necessary to put the plant in operation. It is estimated that the force required in the construction of the coke ovens will reach 1000 men and that the other concrete work will require 1000 to 1500 men, while a like number of laborers will be required in the railroad work, steel erection and other construction, bringing the total construction force considerably above the number of men required to operate the existing plant.

Foundation Work Carried on with Five Concrete Plants

The concrete work is being developed progressively so as to keep five plants busy and to provide for a start on steel erection and machinery installation early in the work. The soil under much of the site, which is clay and gravel, furnishes a good foundation. In some filled areas, however, piles are required. Wood piles were driven to support the first plate mill, the new blast furnaces and some of the byproduct buildings at the coke plant. The excavation for the foundations of these buildings was largely handled by locomotive cranes and turntable travelers using grab buckets and loading into dump-cars. The spoil was mostly used in the fill for the new railroad yard.

The concrete for the coke ovens is being placed by a steel tower mounting two hoppers located on a line between



MASSIVE FOUNDATIONS FOR PLATE MILL CONCRETED WITH TWO TRAVELING TOWERS

the two batteries of ovens. The mixer at this tower is supplied by overhead bins, filled by locomotive crane from railway cars. The brick for these ovens, on arriving at the site, is stored on the inshore side of the plant, opposite the concrete tower.

On the remainder of the foundation work, which requires about 150,000 yd. of concrete, the contractor is using two stationary and two traveling concrete towers, and has also employed an additional mixer mounted on a short tower for part of the blast-furnace foundations. The largest of these stationary plants, consisting of a double-cage tower 170 ft. high and two mixers supplied by large overhead bins loaded by a stiff-leg derrick, is located at one end of the site of the new generating station and will cover the extensions to the gas blowing-engine plants. The other stationary spouting plant, with a much shorter single tower, is set up at the blast furnaces.

The two traveling concrete towers, each mounting its own one-yard mixer and hoisting engine, are being used at present on the foundation for the first plate mill. After completing this work they will be moved to the site of the new blooming mill. These plants, described in detail on page 415 of this issue, are operated on a 14-ft. gage track on which were mounted the "whirlers," or turntable travelers, that handle the excavation, thus reducing the cost of installation by making one broad-gage track serve for all the work at each site. The travelers referred to are identical with that used by the same contractor on the Sciotoville bridge, and described on page 506 of *Engineering News* for Sept. 9, 1915.

SMALL MIXER POURS FOOTINGS AT BLAST-FURNACE SITE

Material Received by Rail and Water

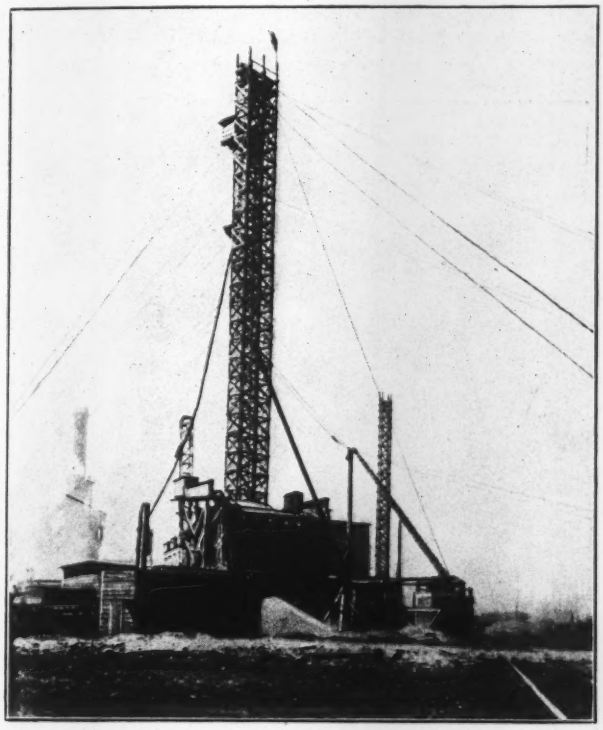
Dredged sand and gravel from the bay are used in the concrete work. The gravel supply available from this source, however, is insufficient, because the deposits being worked contain too much sand. On this account it is necessary to supplement the supply of aggregate with crushed limestone, which, with the cement, is received by rail.

One of the company's docks, on which four derricks are mounted, is used for unloading sand and gravel. This is dumped into hoppers and loaded into cars for distribution on the work. At this dock is also handled material received by scow for completing the fill at the new railroad yard. Ample storage space for concrete materials is available at the site of each concrete plant.

Steel Erection Starts at Plate Mill

The structural-steel frames for the buildings will be erected by locomotive cranes, work having already started, on Mar. 9, at the first plate mill. This mill, one of the first points at which work was begun, is desired at an early date and is expected to be in operation next fall. The entire work, however, will probably not be completed until a year from that time. The structural steel for these buildings is being fabricated at the Steelton shops of the Bethlehem Steel Bridge Corporation. The buildings are all designed with the Aiken type of steel-frame and concrete roof, which furnishes daylight over the entire floor area of the building.

At present, the branch of the Pennsylvania R.R. which terminates at the Sparrows Point station crosses the site of the plant diagonally from northwest to southeast. As this line interferes with an economical operating layout for the completed plant, the railway is to be relocated so as to run around the north and east sides of the square, the north side being chosen as the site for the new freight yard. In order to carry out this relocation it was necessary to fill an indentation in the north shore of the island. As the spoil from the excavations for the new construction was insufficient to make this fill, it was necessary to borrow material elsewhere. As the Point itself is very low,



TALL TOWER TO REACH EXTENSIONS TO THREE BUILDINGS

a pit was opened across the bay from the docks at the south side of the property and material transported about two miles by scow. Slag is also being used in making the fill, which is being pushed out from shore by direct filling.

The entire work is under the direction of F. W. Wood, general manager of the Maryland plant of the Bethlehem Steel Co., and the design and supervision of construction on the improvements fall directly under the charge of A. E. Keller, chief engineer of that plant. The work of the Dravo Contracting Co. is being carried out by J. F. Miller.

Creosote Affects Tar and Asphalt Fillers

Tests on paving block fillers recently made by the Forrest Products Laboratories showed that both asphaltic and coal-tar fillers are seriously affected by the absorption of creosote from the paving blocks. The melting point, specific gravity and viscosity were all lowered. A filler has been prepared and is under test which is expected to be less objectionable than any now in use.

Oregon County Awards Prizes for Maintenance of Roads

Committee of Engineers Judges in Contest To Increase Efficiency of County Road Supervisors

By HOWARD W. HOLMES
Designing and Consulting Engineer, Portland, Ore.

IN ACCORD with the movement to promote highway betterment, the Corvallis (Ore.) Commercial Club in coöperation with the Benton County Court conducted a contest among the various road supervisors in the spring of 1915. Letters were sent out by the court inviting all supervisors to enter the contest and explaining in a tentative way the nature and purpose of the work. Replies were received from 22 of the 28 supervisors, indicating their willingness to take part. To stimulate this interest, the Corvallis Commercial Club offered sums of $300, $200 and $100 respectively as first, second and third prizes. The County Court supplemented these rewards by equivalent sums to be expended on roadwork or in the purchase of road machinery.

Contest Rules Drawn by Three Engineers

Professor G. V. Skelton, professor of highway engineering, Oregon Agricultural College, C. E. Beardsley, city engineer, Corvallis, and the writer were appointed to formulate plans and rules of the contest and to make the inspections and subsequent ratings. Inasmuch as the conditions in the different districts varied between wide limits as to general topography, available road materials, traffic movement and the amount of money available, it was not until after much deliberation that a basis of judging and rating was agreed upon.

Out of a total of 497 miles of public highways, 336 miles consists of earth roads, 141 miles of gravel roads and 20 miles of broken-stone macadam. On the basis of this distribution and in consideration of the fact that the greater portion of the work consisted of repair and maintenance of existing roads, the accompanying schedule was adopted:

Factor	Relative Weight
Drainage:	
Crown	10.00
Side ditches	8.00
Culverts	5.00
Subsoil	3.00
Repair	15.00
Maintenance	15.00
Managerial Ability:	
Nature of work	3.75
Distribution of funds	7.50
Operating efficiency	3.75
New construction, permanent and temporary	18.00
Safety:	
Sight	4.00
Marginal	6.00
Appearance	1.00

In any particular case, of course, the factors to be considered as well as the relative weights of each would depend on the general character of the roads and other local conditions.

Most Supervisors Welcome Expert Advice

The first inspection was made in the spring, and in the majority of cases the supervisors accompanied the judges in their respective districts. The former were thus given an opportunity of explaining their work, and at the same time opportunity was afforded to question the supervisors on matter pertaining to their efforts and their

future plans. The judges called attention to good and bad features of the work and gave such advice as seemed warranted in each particular case. While the interest shown by the majority of the supervisors was very gratifying, many defects were noticed throughout the entire mileage. As is usually the case with earth, gravel and other secondary roads, lack of attention to details was very evident.

Great Improvement Shown

After a careful explanation of the causes of the existing defects and suggestions as to their remedy, a considerable improvement was observed on the second inspection trip made in the fall. In general, drainage conditions were much improved—particularly as to crown and side ditches. A marked effort had been made to improve the sight distance, and a very considerable improvement was seen in the matter of surface repairs and distribution of material. In a few instances, in an endeavor effectively to drain the roadway, the road was so shaped as to compel traffic to track along the center line. So pronounced was this effect in five districts that the judges were compelled to give second ratings of less percentage than those first allowed.

An appreciable saving in road material was accomplished in nearly all districts by utilizing materials in the roadway area obtained by cutting down objectionable peaks, at the same time facilitating drainage and traffic movement.

A decided improvement in the condition of the roads was generally observed. Work in five districts, however, fell short of a reasonable standard of efficiency, and no improvement whatever was noted in three districts. The supervisors of the remaining 14 districts were credited with an average increase of 22%.

Reveals Defects of Supervisor System

In consideration of the economic and practical results and the friendly rivalry developed among the men in charge of the districts, it was quite apparent that the expense involved and the time consumed in conducting the contest were profitably employed. However, as only in rare cases does a road supervisor retain his authority for a greater period than two years, the defects of the supervisor system were developed in a most conspicuous manner. Each successive administration of road officials wastes public funds in gaining experience, and in but few instances is any attempt made to curtail this extravagance.

Contests along the lines referred to may be recommended as a means of greatly increasing the efficiency of layman road officials and stimulating greater interest in this important phase of highway development, with the assurance of a large saving and better distribution of funds appropriated and subscribed for this purpose. Much of the success in this particular effort to promote efficiency and road betterment was due to the untiring efforts of W. H. Malone, county judge.

$100,000,000 to Southern Roads

A detailed investigation of the condition of roadbuilding in 16 Southern and Southwestern states leads to the estimate that $100,000,000 will be spent there for roadwork during the current year. This figure does not include Federal aid funds.

Concrete Arch Bridge for Railway Crosses River on Reverse Curve

Skew Crossing, Steep Grade and Varying Span Lengths Further Complicate Construction—Expansion Joints at Short Intervals

CURVES at each end reverse to each other, a steep grade, a skew crossing and varying span lengths required to cross a river and railroads on each of its banks combined to complicate the construction of the reinforced-concrete arch bridge now approaching completion at Manayunk, Penn., where the present structure of the Pennsylvania R.R. is being replaced on entirely new alignment. The old bridge, built in 1884, had become too light for present traffic requirements, and the

NEW PENNSYLVANIA R.R. BRIDGE CROSSES SCHUYLKILL RIVER ON CURVE

decision to adopt concrete arches resulted from the desire to improve the architectural appearance, in addition to the economy over steel at the then prevailing prices. Constant spandrel arch spacing was maintained throughout, although four varying span lengths were necessary to fit the topography at the site.

Location and General Dimensions

This bridge is located at Manayunk, Penn., where the Schuylkill Division of the railroad crosses the Schuylkill River. The total length is approximately 1200 ft. for the concrete structure between the massive end piers, with plate-girder viaduct approaches at each end. It replaces the old iron deck-truss spans, which rest on masonry piers erected 32 years ago.

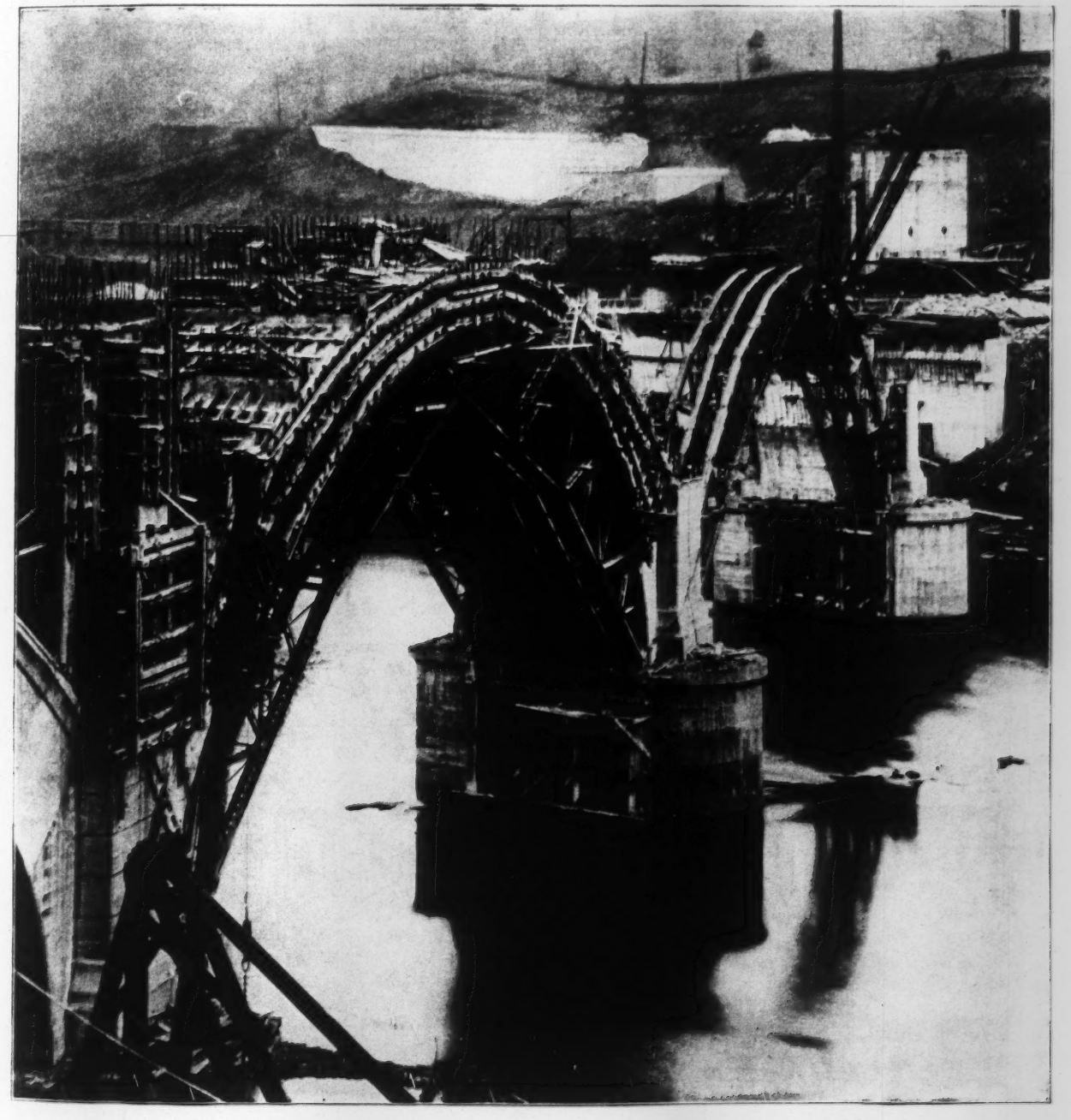
The alignment of the new bridge is radically different from that of the old, the skew crossing being about 65°.

the main 150-ft. spans over the river being on a tangent; the spans on each side, however, are on 6° curves in reverse directions. At the north approach is one steel through girder span, then a massive pier about 40 ft. long, followed by two 105-ft. spans (one over Green Lane and one over Main St.), then a 120-ft. span over the canal, followed by the three main 150-ft. spans over the river, one 120-ft. span and finally two 90-ft. spans at the south end, with a similar terminal pier and a deck plate-girder approach viaduct over the Philadelphia & Reading R.R. tracks. The rise of each arch is one-third the span length, except the 105-ft. spans, which have a rise of 30 ft.

As noted on the accompanying drawings, the widths of arch barrel and the spandrel arch openings are constant for all spans, making it possible to use the same form units for the spandrel arches.

Design Stresses—Frequent Expansion Joints

The live-loading for the double-track structure was assumed as 600 lb. per sq.ft. equivalent uniform load for the arch spans. The unit-load method was applied in the arch analysis; it was found, however, that temperature stresses produced by the assumed variation of 40° generally governed. The unit stresses allowable were 650 lb. in the concrete and 16,000 lb. in the steel.



THREE-HINGED STEEL CENTERS WERE USED FOR ARCHES

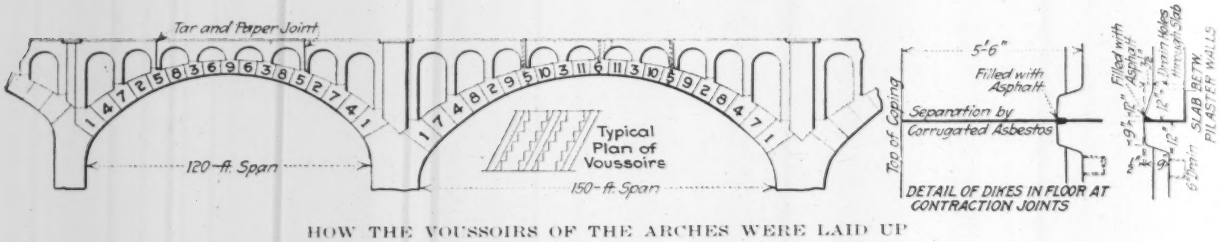
Expansion joints in the superstructure of the floor system are provided at the quarter points and over the hollow piers, as shown in one of the drawings. Asbestos or tar paper was placed at the joints.

Hollow Intermediate Piers

Economy in the high intermediate piers was attained by using reinforced pilaster and spandrel walls above the main arch ribs. These facing pilasters are 3 ft. thick, with deep panels inset 4 in. below the main face of the walls, and steel on the outside faces only. Manholes near the crown of each arch give access to the spandrel openings for inspection purposes, and drainage is provided by pipes and downspouts along the center line between tracks. The intermediate piers are solid below the arch ribs, made unsymmetrical to resist unbalanced thrust when adjacent spans are unequal. The main river piers were constructed within timber cofferdams sunk to rock, the water being relatively shallow.

The construction of the main arch ribs proceeded by symmetrical pouring of given sections, with offset steps on the skew, as noted in the plan above. Steel centers were used.

The design of this structure was made by the engineering department of the Pennsylvania R.R. Co., under the supervision of H. R. Leonard, Engineer of Bridges and Buildings. The contractor is T. L. Eyre, of Philadelphia.

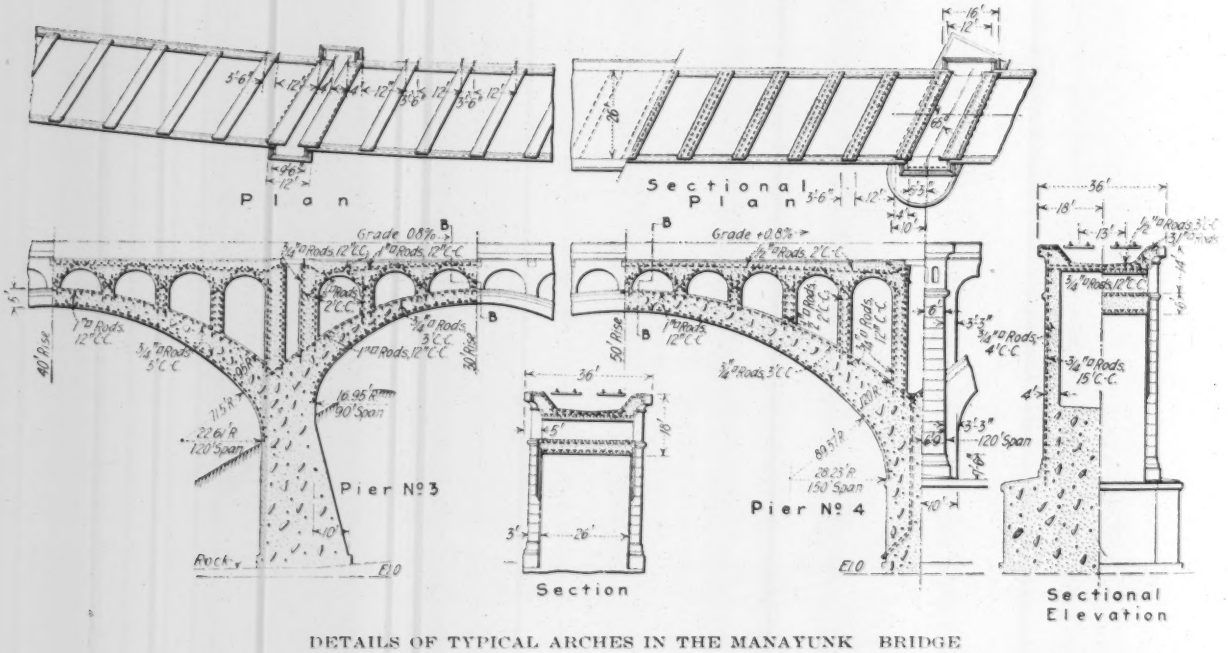


HOW THE VOUSSOIRS OF THE ARCHES WERE LAID UP

Home Labor Requirement on Trial in Philadelphia

Requirement of a city ordinance that all stone used in public improvements shall be cut in Philadelphia has led to an interesting suit, not yet settled. Contract for the construction of a library building was let on the basis of cutting the stone at the quarries, the bids showing a saving of $150,000 thereby.

George E. Datesman, Director of Public Works, says that the old ordinance which governs the case provides that in all contracts for public improvements, including buildings, "the attention of intending bidders must be called to the requirement that all stone shall be cut in Philadelphia, provided the cost to the city will not be greater than under private contract within the city." The meaning of this proviso was not considered clear, and an opinion by the city solicitor raised question as to both its meaning and its validity. The city solicitor furthermore considered that a decision in New York State on a similar clause, where it was held that such a limitation is against the constitution of the state and against the Federal Constitution, constituted a precedent. Acting on his opinion, the Department of Public Works, in view of the price difference above noted, executed the contract on the basis of having the stone cut outside of the city. This decision has been attacked in the courts. It is now before the state Supreme Court.



DETAILS OF TYPICAL ARCHES IN THE MANAYUNK BRIDGE

Making the B. Coli Test Tell More

Theory of Probabilities Promises Results of More Significance to Water Analysis and Intelligible to Laymen

By MILTON F. STEIN
Sanitary Engineer with John H. Gregory, New York City

IT HAS been the writer's experience that the usual statement of the results of coli tests has not meant very much, even to the maker of the tests, not to mention the layman. If the sample tested is positive, it is impossible to tell whether few or many bacteria were present to cause the positive reaction. The best that has been done has been to estimate to some extent the magnitude of the pollution from the percentage of positive tests. It can hardly be gainsaid, that if the actual number of coli could be stated, the results would be more significant to the expert, and would be intelligible to the layman. In this article the writer has attempted to put the estimation of the number of coli on a mathematical basis and to show how largely the number of tests made affects the accuracy of results.

The questions considered are: (1) What is the relation between the percentage of positive tests and the actual number of coli per cubic centimeter in the water tested? (2) How many tests are necessary to establish this relation with a desired degree of accuracy? (3) What is the significance of several consecutive positive tests in a water in which the percentage of positive tests is low?

The following assumptions are made: (1) That all positive tests indicate coli. If presumptive tests are made, it is assumed that a correction factor has been applied to reduce same to true coli. (2) That there are no violent or erratic changes in the coli content of the water during the period in which the tests are taken.

Theory of Probabilities

From the theory of probabilities we know that, if an event E may occur f times out of a total number of t equally likely occurrences, then the probability of the event occurring at a single trial is $\frac{f}{t}$, or p. The probability of its nonoccurrence is $1-p$, or q. If s trials are made, then the various combinations that may occur are given by the expansion of the binomial $(p + q)^s$, and each separate term of this binomial expansion represents the probability of the happening of the two events in the order given in the above scheme.

If, for example, we have an urn containing a large number of balls, 10% of which are black, the rest being white, then the probability of drawing a black ball in a single trial is $p = \frac{1}{10}$, and the probability of not drawing a black ball is $1 - \frac{1}{10}$, or $\frac{9}{10} = q$. Then if we make 10 trials ($s = 10$), our binomial becomes $(0.1 + 0.9)^{10}$. The expansion of this is given in Table I, and in a parallel column are recorded the actual results of 100 drawings of 10 balls each from an urn containing 10 black and 90 white balls, the balls being returned after each drawing and the contents of the urn being well mixed. The general agreement between computed and test results is apparent, and these have been verified by further tests.

The similarity between the above conditions and those of a sample for the coli test will be noticed, if we consider each ball to represent 1 c.c. of water, the black ones as containing each a colon bacillus, and the drawing of 10 balls as a 10-c.c. sample to be tested. Then the computed probabilities in Table I represent respectively the chances of obtaining 10, 9, 8, etc., coli in the sample. However, since one or more coli will give a positive test, evidently the probability of obtaining a positive test will be the sum of all the probabilities excepting the last one, which is the term 0.9^{10} (in general, q^s) in our binomial expansion. Since the probability of obtaining either a positive or a negative test must be 1 (that is, certainty), the probability of obtaining a positive test (denoted by P) must be

TABLE I. LAW OF PROBABILITIES CHECKED BY TEST

No. of Black Balls	Probability (Computed)	Probability (from Test)
10	0.0000000001	0.0000
9	0.0000000009	0.0000
8	0.0000003600	0.0000
7	0.0000088000	0.0000
6	0.0001380000	0.0000
5	0.0014800000	0.0000
4	0.0111000000	0.0095
3	0.0570000000	0.0860
2	0.1900000000	0.1520
1	0.3870000000	0.3810
0	0.3480000000	0.3710

$$P = 1 - q^s \qquad (1)$$

This is the probability of obtaining a positive test in a single sample, and also the limiting value of the proportion of positive tests to total tests as the number of samples is indefinitely increased.

A consideration of this equation will show that, if low values of s are taken, the curve of the equation approaches a straight line. For instance, taking the extreme case, if we assume 1 colon per cubic centimeter and take 1-c.c. samples, p becomes $\frac{1}{1}$, q becomes 0, and P becomes 1, or certainty. Practically, we know that this is not true, since even if the coli bacilli be considered as uniformly distributed, exactly 1 cm. apart in all directions, it would be quite possible to withdraw 1-c.c. samples containing no coli. In other words, the above formula considers each cubic centimeter of water as a solid, with coli frozen into a certain proportion of them. To remedy this defect we proceed as follows:

Let

Q = Probability of a negative test, where $P = 1 - Q$;

m = Number of units containing 1 B. coli, so that $p = \frac{1}{m}$;

xm = Number of units tested, x being any whole number or fraction.

Then,

$$Q = \left(1 - \frac{1}{m}\right)^{xm} \qquad (2)$$

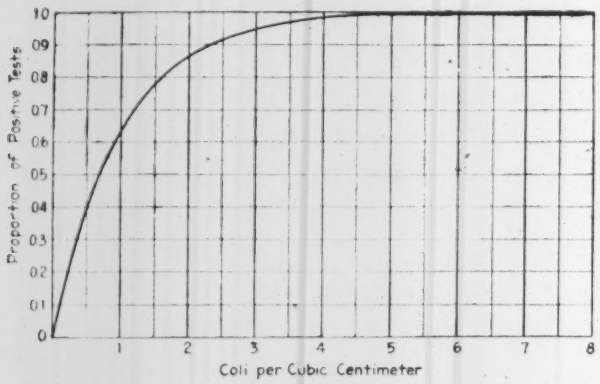
TABLE II. VALUES OF Q FOR INCREASING VALUES OF m

m	$1-\frac{1}{m}$	$\left(1-\frac{1}{m}\right)^m = Q$
1	0.0	0.0
2	0.5	0.25
3	0.67	0.30
4	0.75	0.316
5	0.80	0.328
6	0.833	0.335
7	0.857	0.340
8	0.875	0.344
9	0.889	0.346
10	0.90	0.349
20	0.95	0.359
40	0.975	0.363
80	0.9875	0.366
100	0.99	0.366
1,000	0.999	0.368
10,000	0.9999	0.3681
100,000	0.99999	0.3685

If we let $x = 1$, and compute the values of Q for increasing values of m, we obtain the results in Table II.

It will be seen that, for larger values of m, Q does not increase perceptibly, so that we may take Q for $x = 1$, as 0.37, with the assurance that it will not vary perceptibly through a large range of values for m. Our formula now becomes $Q = 0.37^x$, or

$$P = 1 - 0.37^x \qquad (3)$$



RELATION BETWEEN THE PROPORTION OF POSITIVE TESTS AND COLI PER CUBIC CENTIMETER FOR 1-C.C. SAMPLES

where

P = Proportion of positive tests;

x = Ratio of cubic centimeters tested to the number containing 1 B. colon.

In this form the formula has the desired flexibility. Table III gives, in columns 6 to 10, the coli per cubic centimeter for the more usual sizes of samples taken and for various proportions of positive tests.

In using the formula it is more conveniently put in the form

$$x = \frac{log\ Q}{log\ 0.37}$$

Thus, if the proportion of positive 100-c.c. tests is 0.138, then

$$x = \frac{log\ 0.138}{log\ 0.37} = 1.99$$

and the number of coli per cubic centimeter $= \frac{1.99}{100} = 0.0199$.

In considering a series of n tests for the purpose of establishing the value of P, we are interested in ascertaining the expected deviation of the ratio of positive to total tests obtained from the true value of this ratio. Still assuming that the number of coli per cubic centimeter does not vary during the series of tests, this expected deviation or "mean error" is given by

$$\varepsilon = \sqrt{\frac{PQ}{n}} \qquad (4)$$

The writer has found experimentally that the error obtained usually approximates the mean error ε quite closely, so that it may be used as a criterion in determining the number of tests necessary to obtain a desired accuracy. Columns 2 and 3 of Table III give the number of tests needed to determine the coli concentrations in the following columns to ± 5 and $\pm 10\%$ respectively, based on the above formula for ε, but also taking into account the relative rates of change of P and the coli concentrations.

While ε is the most probable error, there may occasionally be considerable deviation from it. To make absolutely certain that our results do not depart from the true value by more than a desired amount, use must be made of Tchebycheff's criterion. This states that the probability of a deviation from the true value not larger than λ times the mean error is greater than $1 - \left(\frac{1}{\lambda}\right)^2$.

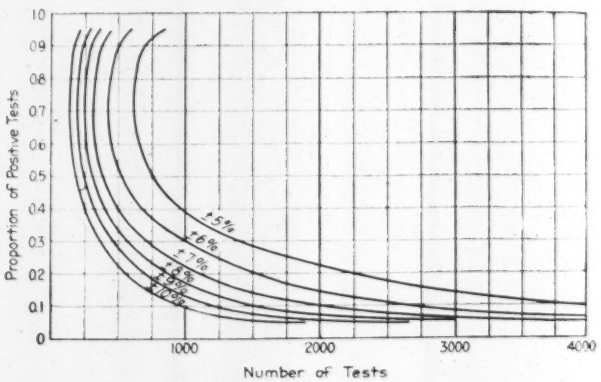
Thus, for

$\lambda = 3$, probability $> 1 - \frac{1}{9} = 0.888$;

$\lambda = 4$, probability $> 1 - \frac{1}{16} = 0.937$;

$\lambda = 5$, probability $> 1 - \frac{1}{25} = 0.960$;

showing that a deviation from P greater than four or five times ε is extremely rare.



NUMBER OF TESTS REQUIRED TO ESTABLISH ANY PROPORTION OF POSITIVE TESTS WITH A DESIRED DEGREE OF ACCURACY

Applying this to the example already considered above, if the value 0.138 has been established by three hundred and sixty-five 100-cc. tests, then

$$\varepsilon = \sqrt{\frac{0.138 \times 0.862}{365}} = \pm 0.018$$

The expected error is $\frac{0.018}{0.138}$, or $\pm 13\%$. We are practically certain that the error does not exceed four times 0.018, or 0.072, which is $\pm 50\%$, indicating that even the result of a year's tests may not be as reliable as is generally assumed.

If the number of coli per cubic centimeter varies during a series of n tests, the value of ε, which must be determined by a modified formula, will be greater than if no variation takes place and will depend on the rate of variation and the range thereof. Since these are not

definitely determinable in actual practice, the discussion of such cases is of little value. However, appreciably to affect ε, such variations must be larger than usually occur in the coli content of natural waters, when tests are taken 24 hours apart.

If the probability of obtaining a positive test in one trial is P, the probability of obtaining two consecutive positive tests is

$$P_{r_2} = \frac{1}{\Sigma(1 + 2 + 3 + \ldots + \binom{?}{P} \quad 1)}$$

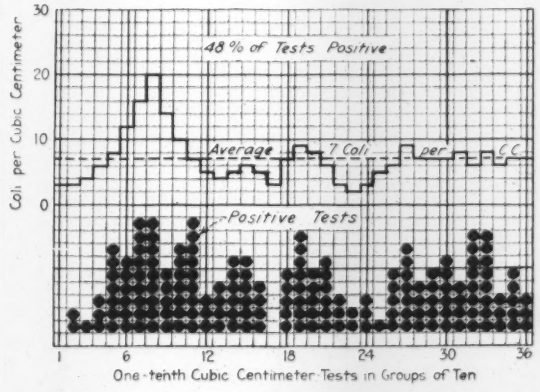
and the probability of obtaining three consecutive positive tests is

$$P_{r_3} = \frac{1}{\Sigma(1 + 2 + 3 + \ldots + \binom{3}{P} \quad 2) + \Sigma(1 + 2 + 3 + \ldots + \binom{3}{P} \quad 3) + \Sigma(1 + 2 + 3 + \ldots + \binom{3}{P} \quad 4) + \ldots\ldots\ldots\ldots\ldots\ldots + \ldots\ldots\ldots\ldots\ldots\ldots + \Sigma(1 + 2)}$$

Values of P_{r_2} and P_{r_3} are given in columns 4 and 5 of Table III.

Conclusions

The foregoing discussion shows that, considered from the viewpoint of the mathematical theory of probabilities, which has been firmly established by the work of many eminent mathematicians during the last two centuries, the following conclusions may be drawn, which are helpful in the making and interpretation of coli tests:



GRAPH REPRESENTING THREE HUNDRED AND SIXTY 1/10-C.C. TESTS OF A WATER CONTAINING A VARIABLE NUMBER OF COLI, AVERAGING 7 PER C.C.

An experimental verification that the test proposed by the Joint Commission's experts for maximum pollution of filterable water indicates 700 instead of 500 coli per 100 c.c.

1. The estimation of the number of coli per cubic centimeter as the product of the proportion of positive tests and the reciprocal of the number of cubic centimeters tested is incorrect. The number of coli may be computed from the size of the sample and the proportion of positive test by means of formula (3) or may be obtained from Table III.

2. The number of tests to give a desired degree of accuracy may be computed from formula (4) or may be obtained from columns 2 and 3 of Table III. These values assume a constant coli content, and a larger number of tests may be required to establish the same degree of accuracy with the variations occurring in actual practice.

3. Inspection of Table III shows that if, in determining the number of coli in a water, a size of sample is chosen giving from 65 to 85% of positive tests, the least number of tests will be necessary to obtain results of a desired degree of accuracy. This suggests that it may be advisable to run several daily samples of the chosen size, rather than a number of samples of different dilutions, as is now done.

TABLE III. COLI PER CUBIC CENTIMETER FOR MORE USUAL SIZES OF SAMPLES AND FOR VARIOUS PROPORTIONS OF POSITIVE TESTS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					Coli per Cubic Centimeter for Samples of				
P	n_{10}	n_5	Pr_2	Pr_3	100 c.c.	10 c.c.	1 c.c.	0.1 c.c.	0.01 c.c.
0.01	9,900	39,600			0.0001	0.00106	0.0100	106	1.06
0.05	1,900	7,600	0.0013		0.0005	0.00516	0.0516	516	5.16
0.10	900	3,600	0.005		0.0010	0.0095	0.0950	950	9.50
0.15	760	3,040	0.013	0.0009	0.0016	0.0158	0.1580	1 580	15.80
0.20	627	2,508	0.022	0.0022	0.0022	0.0220	0.2200	2 200	22.00
0.25	485	1,940	0.036	0.0046	0.0028	0.0284	0.2840	2 840	28.40
0.30	365	1,460	0.048	0.0085	0.0036	0.0360	0.3600	3 600	36.00
0.35	320	1,280	0.067	0.012	0.0043	0.0432	0.4320	4 320	43.20
0.40	282	968	0.100	0.030	0.0051	0.0514	0.5140	5 140	51.40
0.45	235	940	0.130		0.0060	0.0600	0.6000	6 000	60.00
0.50	204	816	0.167		0.0070	0.0700	0.7000	7 000	70.00
0.55	190	760			0.0080	0.0805	0.8050	8 050	80.50
0.60	171	684			0.0092	0.0924	0.9240	9 240	92.40
0.65	165	660			0.0106	0.1058	1.0580	10 580	105.80
0.70	162	648			0.0121	0.1210	1.2100	12 100	121.00
0.75	155	620			0.0139	0.1390	1.3900	13 900	139.00
0.80	156	624			0.0162	0.1620	1.6200	16 200	162.00
0.85	160	640			0.0190	0.1900	1.9000	19 000	190.00
0.90	178	712			0.0232	0.2320	2.3200	23 200	232.00
0.95	210	840			0.0300	0.3000	3.0000	30 000	300.00
0.99					0.0464	0.4640	4.6400	46 400	464.00
0.999					0.0700	0.7000	7.0000	70 000	700.00

P = Proportion of positive tests in a series;
n_{10} = Number of samples to establish coli per cubic centimeter to ± 10%, probable error;
n_5 = Number of samples to establish coli per cubic centimeter to ± 5%, probable error;
Pr_2 = Probability of obtaining positive tests in two successive samples;
Pr_3 = Probability of obtaining positive tests in three successive samples.

4. Table III shows that for small values of P (say 0.10) the probability of obtaining positive results in two successive tests is very small (1 in 200) and of obtaining three consecutive positive tests is extremely remote (one in several thousand). This suggests the use of an additional daily test sample of such size as to give one positive test in 10 or 20, as an indicator for sudden increase in coli content.

Recent Coli Standards

In conclusion, it may be interesting to investigate by the above methods several coli standards promulgated within the last few years. The sanitary experts of the International Joint Commission fixed as the limit of pollution for a water to be subsequently filtered a coli content of 500 per 100 c.c. and stated that this is equivalent to 50% positive results in daily tests of 0.1-c.c. samples extending over one year's time. From Table III, it will be seen that for $P = 0.50$ and 0.1-c.c. samples, the coli per cubic centimeter are 7, or 700 per 100 c.c., and the probable error of 360 tests is

$$\varepsilon = \sqrt{\frac{0.5 \times 0.5}{360}} = \pm 0.026; \text{ or } \frac{\pm 0.026}{0.50} = \pm 5.3\%$$

To test the computed result, 1000 dried beans were taken, 100 beans being considered as representing 1 c.c. Seven of every 100 were blackened to indicate the coli-containing portions. A total of 360 drawings of 10 beans each, with replacements and thorough mixing, gave for P,

0.487, and for ε, $\pm 2.7\%$. More closely to approximate actual conditions, another series of drawings was made, in which the number of black beans was changed after each 10 drawings, but so that the average for the series was 7 in 100. The results are summarized herewith:

Number of trials	360
Number drawn per trial	10
Average number of black beans	7 per 100
Number of trials in which black beans were drawn	172
Proportion of positive tests	$= 172 \div 360 = 0.48$
Computed proportion of positive tests	0.50
Actual error	$0.02 \div 0.50 = 4\%$
Computed error	$\pm 5.3\%$

The sanitary experts for the Treasury Department fixed as the limit of pollution for the drinking water on interstate carriers, one positive 10-c.c. coli test out of five. For $P = 0.2$ and 10-c.c. samples, Table III gives somewhat over two coli per 100 c.c. For a series of five tests only, we would have

$$\varepsilon = \sqrt{\frac{0.2 \times 0.8}{5}} = \pm 0.18$$

That is to say, the expected value of P may be as large as $0.2 + 0.18$ or 0.38—corresponding to a coli content of 5 per 100 c.c. Applying Tchebycheff's criterion with $\lambda = 3$, we see that there is about one chance in 20 that the coli content will exceed 15 per 100 c.c., which in a long series of tests would be equivalent to about 15% of 1-c.c. samples positive—not a very high standard for drinking water. An actual experiment with 10 black beans to the hundred, and 10-bean samples, gave 11 cases of one positive out of five in 100 sets of five drawings each, taken in regular order. While the Treasury Department standard is perhaps as well adapted to its purpose as could be expected it seems worth while to point out the wide variations which may occur, as an example of what is to be expected when only a small number of tests are made.

Water Meters Would Pay Chicago

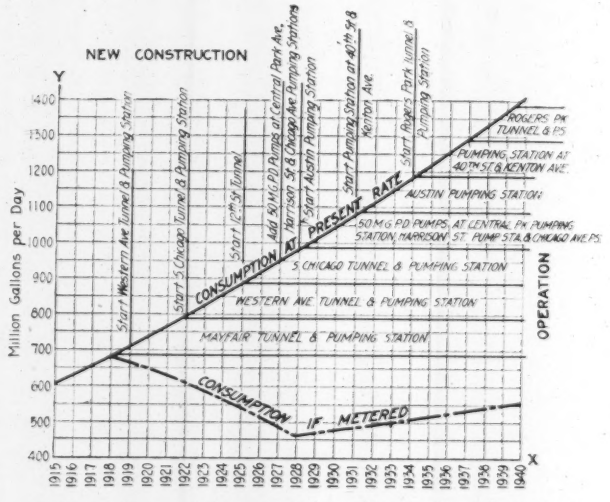
Report Made to City Engineer Contends That Meter Program Would Save Billions of Gallons and Millions of Cash

A CONVINCING argument for the use of water meters, carried home by concrete examples from local and other sources, is embodied in a study made by the staff of John Ericson, city engineer of Chicago. The results of the study take the form of a report by C. C. Saner, designing engineer, to M. B. Reynolds, engineer waterworks design, who in turn submitted the report to Mr. Ericson.

"Water in Chicago," says Mr. Saner, "is 50% used and 50% abused." This means that in 1916 the waste averaged 315,000,000 gal. a day, or about 227 gal. per capita. The injustice of this waste is illustrated by the fact that metered users of 22% of the water pumped in the last four years paid 11% of the water revenue of the city. Assuming that 80% of the water pumped might be accounted for with a fully metered system, meter rates in Chicago might be reduced from $64.39 per million gallons, the present rate, to $40.62. On the 80% accounted-for basis, flat-rate consumers in Chicago pay only $30.14 per million gallons against $64.39 paid by metered consumers; that is, the metered rate is 113% higher than the flat rate. A shifting of relative burdens would be fairer," Mr. Saner states, "for the flat-rate users are the ones who waste the water and cause the consumers remote from the pumping stations to suffer on account of low pressures." Continuing, the report says:

> The question of supplying water to Chicago is the same now as it was in 1860, and it will continue to be the same unless the advice of water-works engineers throughout the world is followed. The present plan is to let the people use, or rather abuse, all the water they want and construct new stations as fast as the pressure becomes low. As this plan has progressed, the use of water by flat-rate users has become greater and greater and will continue to become greater if a remedy is not applied.

The contrast between continuing this antiquated, wasteful and unjust plan and cutting down waste by a full extension of the meter system is graphically presented by the accompanying diagram. By 1940 the consumption would reach a daily average of 1,400,000,000 gal., requiring large additions to the supply capacity at frequent intervals meanwhile. If meters were to be installed gradually until all taps were metered, the consumption would drop every year until 1928, when it would be nearly


NEW CONSTRUCTION
Y
X
Million Gallons per Day
OPERATION
CONSUMPTION AT PRESENT RATE
CONSUMPTION IF METERED
Start Western Ave Tunnel & Pumping Station
Start 5 Chicago Tunnel & Pumping Station
Start 12th St Tunnel
Add 50 M.G.P.D. Pumps at Central Park Ave., Harrison St. & Chicago Ave. Pumping Stations
Start Austin Pumping Station
Start Pumping Station at 40th St & Kenton Ave.
Start Rogers Park Tunnel & Pumping Station
ROGERS PK TUNNEL & PS
PUMPING STATION AT 40TH ST & KENTON AVE.
AUSTIN PUMPING STATION
50 M.G.P.D. PUMPS AT CENTRAL PK PUMPING STATION, HARRISON ST. PUMP STA. & CHICAGO AVE. P.S.
5 CHICAGO TUNNEL & PUMPING STATION
WESTERN AVE. TUNNEL & PUMPING STATION
MAYFAIR TUNNEL & PUMPING STATION

BY USING METERS CHICAGO COULD SAVE ENORMOUS WATER WASTE AND EXPENSE FROM 1918 TO 1940

Without meters the consumption and waste would mount as shown by upper curve, and new pumps and tunnels would be required as shown. The lower curves show how meters would cut consumption and waste and make extensions unnecessary.

down to 450,000,000 gal. a day. The increase in population would then give the lower curve on the diagram a rise, but the present daily rate would barely be attained in 1940.

The comparative costs of the program for metering and the program of new tunnels and pumping stations necessary if flat rates are continued are shown in the accompanying table.

COMPARATIVE COSTS OF METER AND FLAT-RATE PROGRAM CHICAGO WATER-WORKS, 1918 TO 1940

Metered Program	
Cost of meters	$13,233,100
Interest on cost of meters	8,960,200
Maintenance of meters	12,042,770
Operating pumping stations	23,315,978
Additional cost reading meters	1,793,400
	$59,345,448
Flat-Rate Program	
Cost of new tunnels and stations	$17,752,000
Interest cost	7,104,520
Cost of operating stations	46,113,455
	$70,969,975

Engineering Contractors Recover Stranded Submarine "H-3"

After Naval Plan of Salvage Fails, Hull Is Jacked Out of Sand and Moved Overland for Repairs

DURING a fog, Dec. 14, 1916, the submarine "H-3" went ashore on the peninsula at Samoa, near Eureka, Calif. On Dec. 28 the Government opened six bids for the salvaging of the submarine, as follows: $18,000, $27,500, $30,435, $56,000, $58,000 and $72,000. After these bids had been considered a few days, all were rejected and the first-class cruiser "Milwaukee," the monitor "Cheyenne" and the naval tug "Iroquois" were detailed to tow the submarine off the beach at high tide.

This attempt ended disastrously for the $4,000,000 cruiser Milwaukee. Comment on the conditions that resulted in the total loss of that vessel appeared on p. 398 of the *Engineering Record* for Mar. 10. Ten days after the wreck the Government reopened negotiations with the lowest bidder, the Mercer-Fraser Co., of Eureka, Calif., and although the submarine had meantime shifted into a less favorable position, the contract was closed with this firm for the figure originally bid.

Hull Buried in Sand

By the time the work could be commenced the wreck had settled and sand had drifted around it until only 6 ft. of the hull was exposed. The boat was estimated to weigh between 400 and 500 tons, and it was believed feasible to raise it bodily by the use of heavy cables passed beneath the hull. The successful placing of these cables was the first important problem.

The submarine was lying in a position such that at low tide the water receded 75 ft. beyond it, but at high tide it was 200 ft. from the shore line and waves broke continually over its top. It was therefore necessary to lay out the work in such way that it could be carried on at low tide and would not suffer from wave action between working periods. The contractors felt that it would be impossible to make any excavation in the sand under the boat or to pump the water out of a cofferdam around it, because of the quicksand conditions.

Cables Were Jetted Down

The entire plan was therefore centered about the idea of using water jets to get the cables under the hull. A force pump was set up on the beach, and lines of hose were run to both sides of the submarine. Each hose line terminated in a 15-ft. length of 2-in. pipe. To the end of one of these pipes a small cable with a loop in its end was attached. With the pipe in the position where it was desired to place one of the cables, the pump was started and the pipe thrust down at an angle such that it would just pass under the keel of the boat.

When this pipe was down far enough, water was allowed to run slowly through it while a second 2-in. pipe exactly opposite on the other side of the boat was put down. This second pipe was jetted down at an angle such that it would intersect with the one to which the cable was attached and would make a hole in the sand through which a small rod with a hooked end could be used to pick up the small cable from the opposite side.

It was found possible, without a great amount of fishing, thus to pick up these small cables and pull them through beneath the hull. To the small cable a 1-in.

THE CRITICAL TIME CAME WHEN THE BOAT STARTED ON ITS TRIP OVERLAND

cable was then attached and pulled through, and with this the 2-in. cables were drawn through. In this manner seven cables were placed under the hull, two amidships, two forward and three under the heavy after-section of the boat in which the engines are located.

Arrangement of Lifting Jacks

With the cables in place under the hull, cross-timbers to which the cables could be fastened were placed above the hull. These cross-timbers were long enough to extend over the full width of the boat. A set, consisting of four 12 x 12-in. timbers, was placed over each cable, and the cable ends were passed around the timbers and fastened by six Crosby clips. The timbers were carefully leveled when put in place; and thus when the cables were drawn taut, the timbers afforded solid shoulders against which the lifting thrust could be applied.

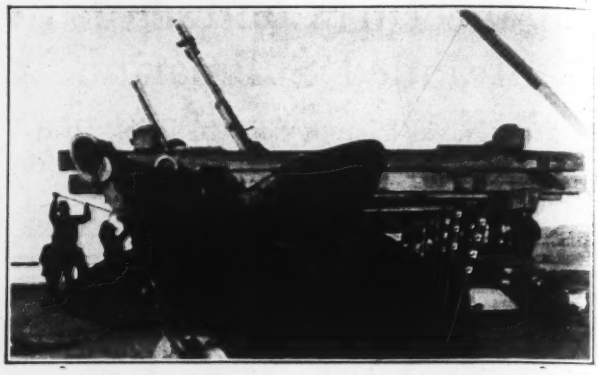
Along each side of the hull, piles were driven and capped; and upon these, heavy timbers were run to support the jacks lifting against the cross-timbers. Fourteen 50-ton Norton ratchet screw jacks were used, one placed under each end of the seven sets of cross-timbers. With this arrangement, and figuring a breaking strain of 140 tons for each cable, it was believed that there was an ample margin of safety if the weight lifted did not in fact greatly exceed 500 tons.

In this manner the boat was raised without difficulty and was blocked up at a level such that the keel cleared the beach. Five sets of timbers were then put crosswise under the keel, and these were blocked up against the hull to prevent it from rolling. These timbers were set on rollers, and a track of 6 x 16-in. timbers was laid for them in the sand. Power for moving was supplied by two hoisting engines, each pulling on a line passing through a pair of five-sheave blocks connected to heavy cables passing around the hull about 50 ft. apart.

The Trip Overland

The critical time of the entire job came when the boat was lowered onto the rollers and the piling was cut away to permit its movement sidewise up the beach. In this position the wreck was so exposed that, had something occurred to delay the work, the incoming tide would have caused the boat to settle again into the sand, involving serious loss and damage.

The danger of this critical situation was enhanced by the fact that the tide was low enough to allow work on the wreck for only 2½ hours at a time. However, great care was taken to have everything in readiness; and after the signal to start pulling was given, there was no hitch in the operations. Within 1½ hours the boat had been moved up the beach 200 ft., beyond the high-tide mark.



CABLES UNDER HULL FASTENED TO CROSS TIMBERS

When the boat was beyond reach of the tides, the cross-timbers were removed and a pine log 80 ft. long and 40 in. in diameter at the small end was placed along either side of the hull. Cables were passed from log to log beneath the keel, and the logs were supported on two cradles 20 ft. wide, made up of 14 x 14-in. timbers solidly bolted together. These cradles were so designed that a central cross-timber transferred the weight from the logs to the cradles only through a transverse timber at the middle of the cradle.

The boat had to be moved overland slightly more than a mile. As it was desired to avoid the expense of grading the sand hills to afford a level roadway, the track was laid over grades up to 4 per cent. On these grades the boat was moved without difficulty by a single hoisting engine and one pair of five-sheave blocks. The average progress was about 550 ft. per day. On the two best days the progress was 930 ft. and 1060 ft. respectively. Throughout the trip a transit was used to keep the tracks parallel and at the same level.

As launched in Humboldt Bay on Apr. 20, three months after the signing of the contract, the submarine was found to be in excellent condition. The trip overland had apparently not bent any plates nor sprung any seams.

The work was laid out and supervised throughout by James D. Fraser, president of the Mercer-Fraser Co., which held the contract for the work.

AT THIS STAGE THE SUBMARINE HAD BEEN RAISED 8 INCHES FROM ITS BED IN THE SAND

Montreal Plant Makes Its Own Electrolytic Chlorine

Installation in Operation Several Months—Costs Compared with Previous Hypochlorite Process

THE USE of an Allen-Moore electrolytic cell, how it is installed, how it operates and what it costs for making chlorine for direct application in water disinfection at the mechanical filtration plant of the Montreal Water and Power Co. were described at the recent convention of the American Water-Works Association by F. H. Pitcher and James O. Meadows, respectively chief engineer and filter superintendent of the company. The following notes are taken from their paper:

The sterilization of public water-supplies with chlorine or chlorine compounds is now standard practice, and this method is well understood; but the production of electrolytic chlorine and the direct application of the gas so produced to the water to be purified is of rather recent date and, except in a general way, is but little understood by the water-works fraternity.

The electrolytic-cell installation of the Montreal Water and Power Co. has been in service since only the first part of 1917, but during that time many interesting data have been secured.

The chlorine-cell installation includes a salt-storage bin having a capacity of 40 tons of salt, the brine saturating and purifying equipment, two 15-hp. motor generator sets, four chlorine cells, and the silver ejectors and distributing lines for applying the chlorine water to the water to be treated.

The brine saturating and purifying equipment consists of three vertical galvanized-iron saturators, 27 in. in diameter by 6½ ft. in height, provided with a spray system at the bottom and an outlet 6 in. from the top and two concrete reaction tanks having a capacity of 82 cu.ft. each. These tanks are built with sloping bottoms and have a pipe grid for air agitation. Two sand filters are provided for filtering the purified brine, which passes from the filters to the two concrete storage tanks, having a capacity of 276 cu.ft. each.

The distributing lines for applying the chlorine water to the water to be treated are 1-in. chemical hose lines. The chlorine gas is ejected into the water by means of a silver ejector, which maintains a 4-in. vacuum on the chlorine cells and takes the gas from the chlorine main through the ejector to the distributing lines.

Allen-Moore Chlorine Cell

The electrolytic cell is of the Allen-Moore type. It is a standard 600-amp. cell and is 7 ft. long by 20⅜ in. wide. Each cell is provided with Acheson graphite anode plates and pure wrought-iron perforated cathode plates. The Allen-Moore cell is of the unsubmerged diaphragm type and uses asbestos paper for the diaphragm material. Unlike several other types of electrolytic chlorine cells, the cell box of the Allen-Moore cell is made of concrete, properly protected at the surface to withstand the chemicals.

The cells are connected in series and are provided with short-circuit switches or cutouts. The voltage carried on each cell is approximately 3.3 volts, and each cell is capable of producing 32 lb. of chlorine per 24 hours.

In preparing the brine solution a small quantity of water under pressure is allowed to flow in at the bottom of the saturators, the saturators being charged with salt. A saturated solution of salt is delivered to the two concrete reaction tanks. A sufficient quantity of soda ash is added to the brine in the reaction tanks to combine with the calcium and magnesium salts present in the brine, and the contents of the tanks are agitated for one-half hour to insure complete mixing of the soda-ash solution with the brine and also to hasten the reaction. The solution is then allowed to remain in a quiescent state for one hour to allow the precipitate formed to settle, when the solution is filtered through the sand filters into the purified-brine storage tanks. A sample of the purified brine is titrated for residual alkalinity, which determines the amount of hydrochloric acid necessary to neutralize the alkalinity and leave a residual acidity of about 0.01%. It is necessary to have the electrolyte slightly acid to prevent the formation of hypochlorites within the cell and the subsequent loss of cell efficiency.

Cost of Chlorine Production

The annual cost of production is estimated as follows:

Salt at $8 per ton	$500
Power at $30 per horsepower	450
Interest at 6% on $5,000	300
Depreciation at 15%	750
Labor and superintendence	500
Total	$2,500

Three chlorine cells furnish the requisite amount of chlorine for sterilization, yielding 90 lb. of chlorine gas per 24 hours, or 32,850 lb. per year, making the cost of chlorine produced 7.6c. per pound.

Comparison with Present Hypochlorite Cost

The annual cost of sterilization previous to the installation of the chlorine cells was as follows:

Chloride of lime at 3.75c. per lb.	$4,105
Interest at 6%	150
Depreciation at 5%	125
Labor and superintendence	500
Total	$4,880

As the amount of chloride of lime required was 300 lb. per day, or 100 lb. of available chlorine, the cost per pound was 13.4c. or 5.8c. per lb. more than chlorine produced by the electrolytic cells.

With normal market conditions the annual cost of the two forms of treatment would be approximately the same, if one did not consider the general depreciation that chloride of lime causes about a water-purification plant.

Operation of Chlorine Cells

An electrolytic chlorine cell functions at its best when under a constant current load, and for this reason it is good practice not to vary the load, or if varied to bring about the change gradually. Variations in load cause a considerable deterioration of the diaphragms, with a consequent loss in cell efficiency. For this reason automatic control of the chlorine production from an electrolytic cell is not practical; and for the treatment of a large volume of water, without appreciable variations in volume, automatic control is not required, for the dosage can be regulated for the maximum requirements without causing tastes or odors during the minimum-consumption periods. The three cells required to supply the chlorine

consumed for sterilization are operated with a current load of 500 amp. and 13 volts. The electrolytic cells require very little attention and up to date have given excellent satisfaction.

The caustic liquor from the cells contains about 12% of sodium chloride and about 10% of NaOH. No recovery of the salt and caustic is attempted, because the amounts of these two chemicals produced are so relatively small that their recovery would not be economical. For large installations the recovery of the salt and caustic is a regular feature of the process, the salt recovered being used over again and the caustic being concentrated and sold as liquid caustic.

Reasons for Adoption

The chlorine-cell installation was adopted because of the saving effected over the present high price of chloride of lime and because of inability to secure this chemical with any degree of certainty; also, because common salt is very much better to handle around a water-purification plant and its use in the chlorine cells does not cause the general deterioration about the works that the use of chloride of lime does. Overdosage with chlorine does not cause the trouble that chloride of lime overdosage does, because odors and tastes are not present to the same degree.

The short experience at Montreal with chlorine cells for the sterilization of a public water-supply indicates that an installation of this kind is perfectly feasible for large water-supplies where the cost of power is not excessive.

Strength Data on Woods

Eleven thousand six hundred strength tests on twenty-five species were made by the Forrest Products Laboratory during the year, raising the total number of tests to 137,000. Strength data are now available upon nearly all American woods of commercial importance. The United States Government now has more thorough and comprehensive data on the mechanical properties of wood than any other nation.

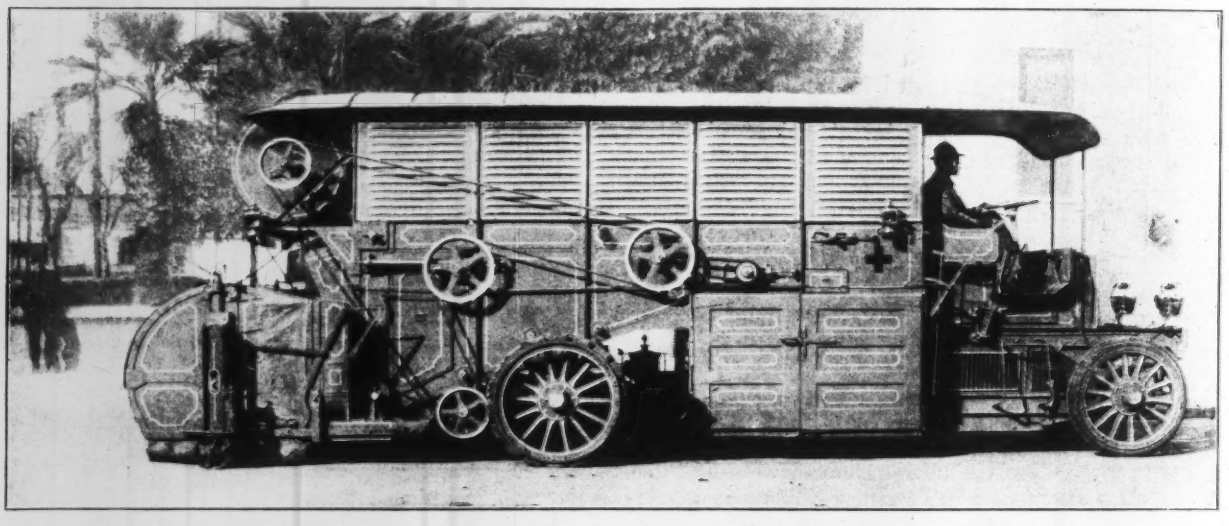
Western Cities Employ Vacuum Machines for Cleaning Streets

Costs Given for Operation of Motor Unit at Oakland, Calif.—Best Results Where Climate Is Dry

AFTER many years of experiment, street cleaning by vacuum apparatus seems to have become an established practice in some of the California cities and in other Far Western cities, notably Colorado Springs, Colo., and Phoenix, Ariz. At the Panama-Pacific Exposition the pavements were cleaned daily by one of the newest types of these vacuum cleaners, a combination of a sweeping and suction machine.

Rotary Broom Adjustable

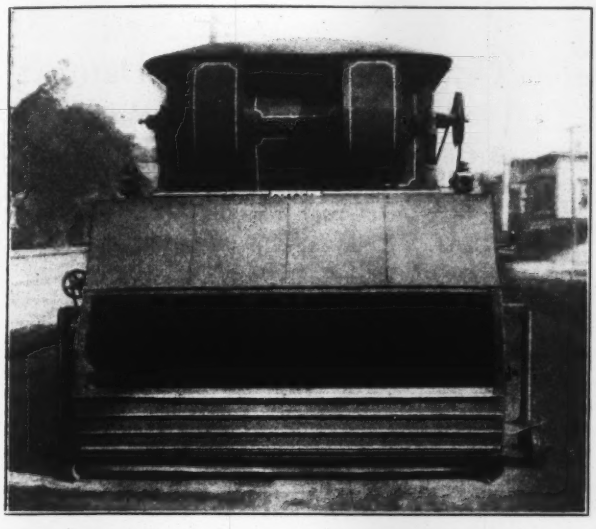
It has a power-driven rotary broom 8 ft. 5 in. wide by 3½ ft. in diameter fully inclosed and so constructed that when it is worn it can be extended and readjusted to give a proper sweeping surface at all times. It can be used down to the stub. All heavy dirt and particles picked up are swept by this broom upon a conveyor and deposited in iron receptacles, which are easily removed from the machine. These receptacles hold about a barrel each, and their position in the machine, as well as the location of the conveyor, is clearly shown on one of the photographs.



BROOM IS DRIVEN BY A SELF-ADJUSTING ROPE DRIVE ON PANAMA-PACIFIC EXPOSITION MACHINE

For taking up dust and light floating particles, there are two fans placed directly over the broom. This arrangement effects the separation in the machine of the heavy dirt and the light dust. The air and dust pass through a separator screen where the dust and fine particles settle on the lower platform, and a small conveyor running at about 30 ft. per min. carries this material into the front receptacle. The broom is driven by self-adjusting rope transmission as shown. The broom carriage is hinged to the back of the machine and rides on a pair of small wheels practically independent of the sweeper itself, thus permitting it to adjust itself to unevenness in the surface of the pavement.

The broom and fan drive is taken from the mainshaft just in front of the transmission, and the clutch is so arranged that the machine can be driven and operated independently of the broom. The sweeper truck is built very low, and its wheels are fitted with solid rubber tires. The speed of operation naturally varies according to the amount of dirt to be removed, but in ordinary work



BROOM IS MOUNTED ON INDEPENDENT CARRIAGE

it will maintain a speed of from 8 to 10 miles an hour with a sweeping capacity of 250,000 sq.yd. in 8 hours.

At the exposition a Butler machine, traveling from 45 to 50 miles each night, kept the whole of the grounds clean, with the exception of the smaller courts, which were too narrow to permit its operation. The contract for cleaning the exposition grounds was taken at 40c. per 1000 sq.yd., and it is stated that a profit of about $15,000 was made in the 10 months on one machine. The next lowest bid was 47c. per 1000 sq.yd. This very machine had previously been in operation in Oakland, and at the close of the exposition had run 27,000 miles and was still in good condition.

The accompanying data are from an official report on tests of a Butler street cleaner made by W. W. Thompson, assistant deputy superintendent of streets, Oakland, Calif.:

DATA ON PERFORMANCE OF MACHINE

Resweeping Clay St. from south line of 3d St. to the south line of 7th St.:	
Length	1040 5 ft.
Width	52 6 ft.
Area	6,080 sq.yd.
Starting time	6:30 a.m.
Finishing time	6:58 a.m.
Dust	97 lb.; 1 89 cu.ft.
Street sweepings	112 lb.; 2 77 cu.ft.
Gutter sweepings	200 lb.; 5 54 cu.ft.
Resweeping 25th St. from east line of Grove St. to west line of Telegraph Ave.:	
Length	1,023 ft.
Width	31 9 ft.
Area	3,625 sq.yd.
Starting time	7:37 a.m.
Finishing time	7:44 a.m.
Dust	72 lb.; 1 44 sq.ft.
Street sweepings	24 lb.; 1 cu.ft.
Gutter sweepings	91 lb.; 3 67 cu.ft.
Resweeping Piedmont Ave. from east line of Broadway to north line of Echo Ave.:	
Length	4,357 ft.
Width	52 ft.
Area	25,173 sq.yd.
Dust	69 lb.; 1 44 sq.ft.
Street sweepings	383 lb.; 8 31 cu.ft.
Gutter sweepings	335 lb.; 13 85 cu.ft.
Total clean-up of sweepings	1½ cu.yd.
Sweeping time	1 hr., 25 min.

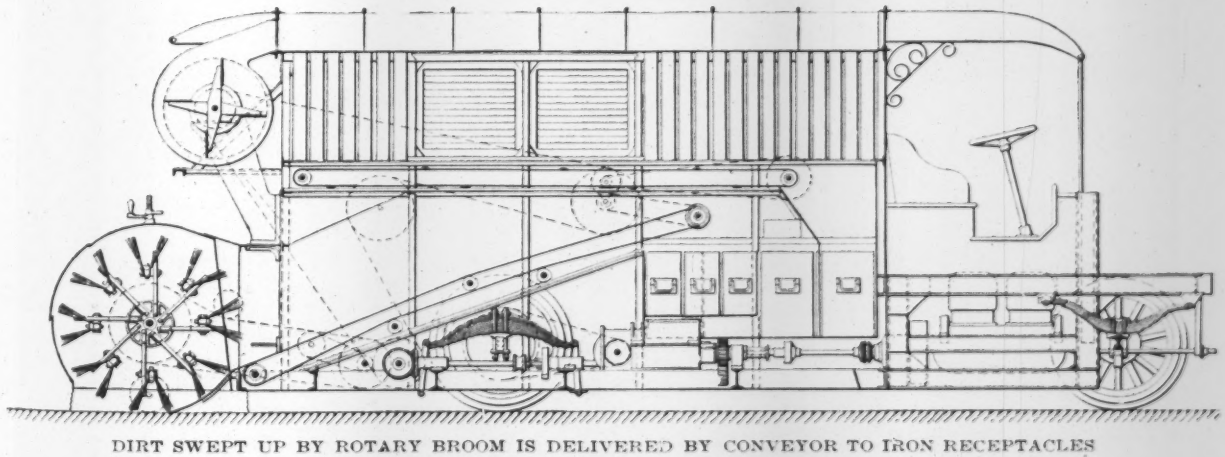
In Los Angeles, Calif., a contract was awarded last fall to W. W. Baxter for street cleaning by vacuum cleaners known as the Baxter machines. This contract was for three years at the rate of 10½c. per 1000 sq.yd. This type of machine, it is estimated, will clean 220,000 sq.yd. of pavement in 8 hours. It has no rotary broom.

Another type of vacuum cleaner, which it is claimed has been used with success at Sandusky, Ohio, and other places, is the design of Bernard Kern and is known as the "Wayclean-se suction street cleaner." This machine has a detachable three-wheel van, or portable bin, for collecting and transporting the dust and sweepings.

The Far West cities where vacuum street cleaners seem to have met with the most success are in relatively arid sections, like Phœnix and Colorado Springs. In these cities ordinary street refuse is speedily reduced to dust, and the damp, slimy conditions met with in Eastern cities, or in the coast cities of the Northwest, are seldom encountered.

Sewer Costs at Vincennes

The cost of sewers per acre in Vincennes, Ind., during 1914-16 averaged $300 for the domestic or sanitary sewers, $285 to $400 for storm sewers in different districts. Streets are not included in the area assessed. The cost is said to be higher than is usual in other cities owing to local conditions.



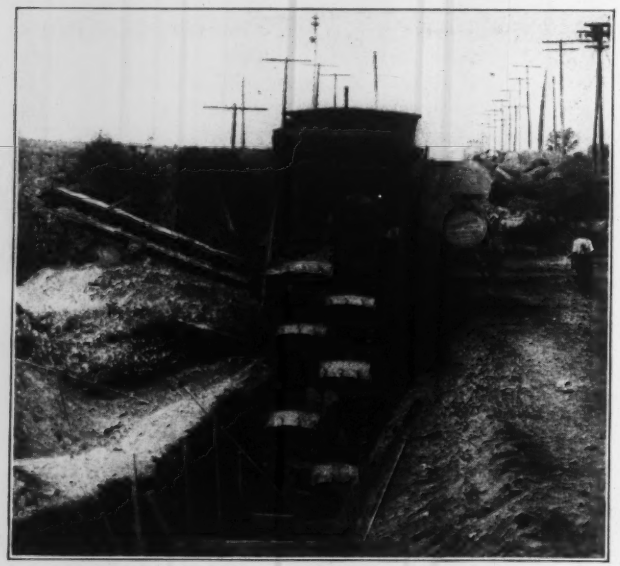
DIRT SWEPT UP BY ROTARY BROOM IS DELIVERED BY CONVEYOR TO IRON RECEPTACLES

Minneapolis Digs Large Water-Main Trenches by Machine

Excavation for 54-Inch Main Cost 9.3 Cents per Cubic Yard—Backfilling Done by Steam Shovel for 21.2 Cents

MINNEAPOLIS appears to have the only municipally owned water-works trenching machine in Minnesota. It is an Austin excavator and will dig a trench 72 in. wide. It cost $10,000. The city lays its own water mains and continues to do all small work by hand trenching.

The cost of operating this excavator 66 working days for a 54-in. force main, at an average depth of 11 ft., was $3665, divided as follows: Repairs, $808; coal and oil, $519; labor, $2308. The volume of material excavated, based on daily reports, was 39,200 cu.yd., or by computation on approximate sections, 43,700 cu.yd. The cost per cubic yard, based on the daily reports, was 9.3 cents.



MINNEAPOLIS USES THIS EXCAVATOR FOR BIG WATER-MAIN TRENCHES

Labor was paid as follows: Foreman, $4.50; timekeeper (one-fourth of his time, as he was on four jobs), $1; engineer, $4; watchman, $3; fireman, $2.75; laborers, $2.50; team, $5. The cost of repairs was thus divided: Labor, $3.58; repair parts, $3.52; repair work at local shop, $98.

Cost of Backfilling by Steam Shovel

Backfilling was done by means of a small steam shovel. The job was in the outskirts of the city, and the excess dirt was easily disposed of. Cost figures are not available, but on another job in a built-up part of the city the backfilling of a 48-in. main 9520 ft. long cost $1146, or 0.48c. per cu.yd. The cross-section averaged 75.3 sq.ft. gross, or 62.8 net, for backfill, after deducting 12.5 sq.ft. for the 48-in. pipe. There were 22,143 cu.yd. in the trench and 1590 cu.yd. in bell holes, making a total backfill of 23,733 cu.yd. against a total excavation of 29,757 cu.yd. The cost of the backfilling, plus the hauling away of excess material (6024 cu.yd.) and the refilling of the street surface, was $6302, or a unit cost of 0.212c. The cost of removing excess material and refinishing the street surface was $0.839 per cu.yd., a high cost due to long haul.

The steam shovel engineer was paid $6 a day. Other daily wages, all for 8 hours, were: Foreman, $2.75; watchman, $3; assistant foreman, for hauling material away, $3; teams, $5; and two pitmen, $2.50 each. Arthur J. Jensen is supervisor of water-works.

Ohio Flood-Control Dam Has Duplex Outlets

Small Opening for Ordinary Floods—Draft Tube from Upper Outlet for Great Floods

A SPECIAL problem met in planning for retarding-basin control of the Scioto River above Columbus, Ohio, was solved by provision of duplex outlets in the dams. Conditions in the Scioto Valley made it economically necessary to check even the moderate summer floods—for protection of farm land in the river flat—while yet giving full-head discharge for large floods. The Dublin dam, designed by the Franklin County Conservancy District to be located a short distance above Columbus on the Scioto River, is to be the city's essential reliance for adequate protection against great floods, and therefore the duplex-outlet scheme was applied only after close study of all possible mischances in operation.

In the dams of the Miami River flood-protection enterprise (*Engineering News*, Jan. 18, 1917) simple base outlets are used, because the valley is of such character that minor summer floods play no material part in the problem. The Scioto Valley, on the other hand, contains much land flooded in summer freshets with loss of crop value, and great benefits were obtainable by control of these floods of small total volume. This object was attained by making the discharge conduits at the base of the dam so small that they throttled the summer floods down to the desired maximum flow, and by providing at higher level the inlet to an enormous funnel-shaped draft tube capable of handling the discharge of great calamity floods.

Discharge Through Large Funnel

The discharge through the large funnel involves a considerable loss of discharge capacity at low overflow height, as compared with large outlets at the base of the dam; but by the time the reservoir is half to two-thirds full, it is expected, the loss of head due to the funnel arrangement will be rendered negligible by the draft-tube effect of the full-flowing funnel.

These "cat-and-kitten" outlets, as they were called by John W. Alvord, of the engineers for the Conservancy District (Alvord & Burdick, of Chicago), are shown by the drawings herewith. They have an additional feature not mentioned above—namely, provision for ponding water at will in the lower part of the basin. This is accomplished by gates in the main base outlets and by auxiliary base outlets fitted with needle valves, through which the ponded water can be drawn off. The gates in the "kitten" outlets can be closed in winter so as to pond up the river flow to the level of the large outlet funnel, for providing a supplementary water-supply for the Co-

lumbus system, which is (or soon will be) short of water in the winter months. This feature, however, is not itself a part of the duplex-outlet scheme.

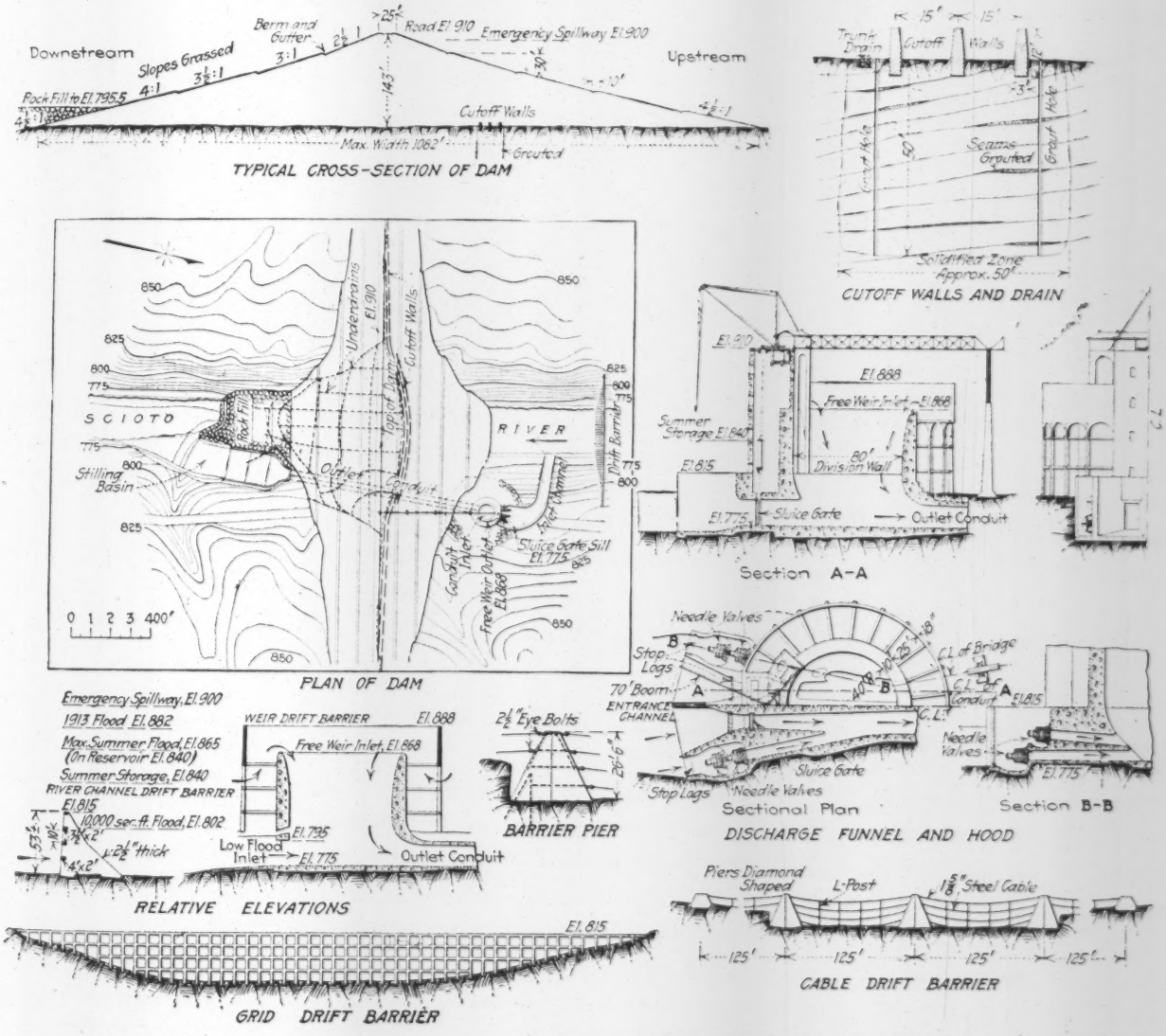
The discharge funnel is a circular concrete-walled inclosure, 80 ft. inside diameter, with walls 10 ft. thick at the base, the inside diameter enlarging a little to a rounded weir crest at the top. The two horizontal outlet conduits cross directly under the funnel and communicate with it by smoothly tapering throats.

Surrounding the funnel is a huge reinforced-concrete hood, circular in plan, 150 ft. in diameter, forming an unbroken cylinder from a little below the weir crest to 20 ft. above the crest. This hood, supported by columns below, allows free access of the water to the circular weir, but keeps all drift away at those water stages in which there is distinct weir flow into the funnel.

The hood around the discharge funnel is supplemented by two other drift-catching devices. Far upstream, at the head of the reservoir area, a wire-cable barrier, supported by concrete piers spaced 125 ft. apart, is placed to catch all drift originating above the basin. This follows in its general idea similar barriers already in use elsewhere, as on the White River in Washington.

Near the dam a concrete grid is constructed across the valley bottom. Its maximum height is about 53 ft. This is to protect the entrances to the small flood outlets and the water-supply outlets. The structure consists of piers spaced 10 ft. apart, each 2½ ft. thick, similar to the piers of a hollow concrete dam, and horizontal beams connecting the piers at 10-ft. clear distance vertically, thus forming cells or meshes of the grid 10 ft. square.

For the present the construction of this dam is not in prospect, on account of the decision of the Franklin County Conservancy Court that the plan of the district would cost more than the benefits. The duplex-outlet device, however, has found much favorable comment among hydraulic and flood-protection engineers and is likely to be retained if the Dublin dam is built in connection with the flood-protection channel work of the City of Columbus, as has been discussed in recent months.



DESIGN OF DUBLIN DAM WITH SMALL BASE OUTLETS AND LARGE UPPER HOODED DRAFT-TUBE OUTLET AND DRIFT BARRIERS

Would Depress New York Central and Elevate Lackawanna Through Syracuse

Use of Erie Canal East of Business Center Recommended in Report by Bion J. Arnold—West of New Station Route Would Follow West Shore Right-of-Way—Union Station, To Include Lackawanna, Considered Not Now Warranted

UTILIZATION in part of the bed of the Erie Canal and in part of the West Shore right-of-way for the New York Central and retention of its present right-of-way for the Lackawanna are the salient features of the solution of the Syracuse (N. Y.) grade-crossing problem recommended by Bion J. Arnold, consulting engineer, of Chicago, retained by the city to study the situation. The problem has long been under study by the railroads concerned, and in latter years by the Syracuse Grade Crossing Commission, of which Henry C. Allen is chief engineer; and in the report recently presented Mr. Arnold admits that the plan he recommends is with certain modifications one of those worked out by the commission. A more elaborate scheme, which he designates the ideal plan, would divert the Lackawanna to the New York Central tracks through the city, and possibly carry Lackawanna through freight around the city entirely and north of Onondaga Lake. He concedes, however, that the present business of this line of the Lackawanna would not warrant constructing this detour. Mr. Arnold considered 22 plans, involving track elevation, track depression, tunnels and detours. All, however, except the two referred to seemed to him objectionable for reasons that he states.

Specifically, the plan recommended by Mr. Arnold calls for retention by the Lackawanna of its own right-of-way, station and freight facilities, the tracks being elevated but carried on a ballasted viaduct and not on solid embankment; depression of the New York Central lines through the city, both New York Central and West Shore occupying the bed of the Erie Canal from the east as far as State St. and then swinging north to the West Shore right-of-way; construction of a station at West Genesee St. and West St., with headhouse so placed as to permit of future widening of the train yard; utilization of the present Oswego Canal in three ways, by an interurban entrance to the city, an industrial lead track and between them a paved roadway (R. W. & O. passenger trains using a new entrance along the Syracuse Junction Ry.); use of the present New York Central station partly as an interurban terminal and partly, because it is too large for that alone, as a market; and the creation of a civic center in the heart of the city at the point where the New York Central would swing from the Erie Canal to the West Shore right-of-way. The estimated cost of the Lackawanna work, including new station, is given as $1,500,000; that of the New York Central as $6,000,000.

The New York Central has always contended for the use of the West Shore tracks, elevated, throughout the city. An official of the company has informed the *Engineering News-Record*, however, that a detail study is be-

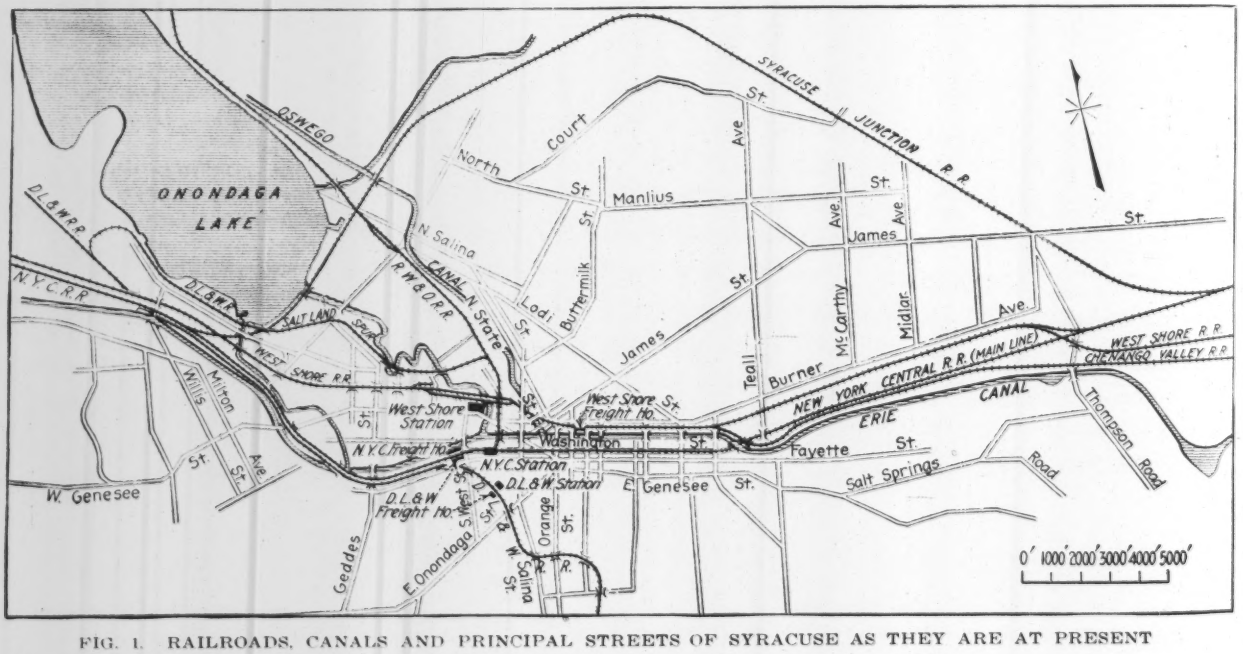


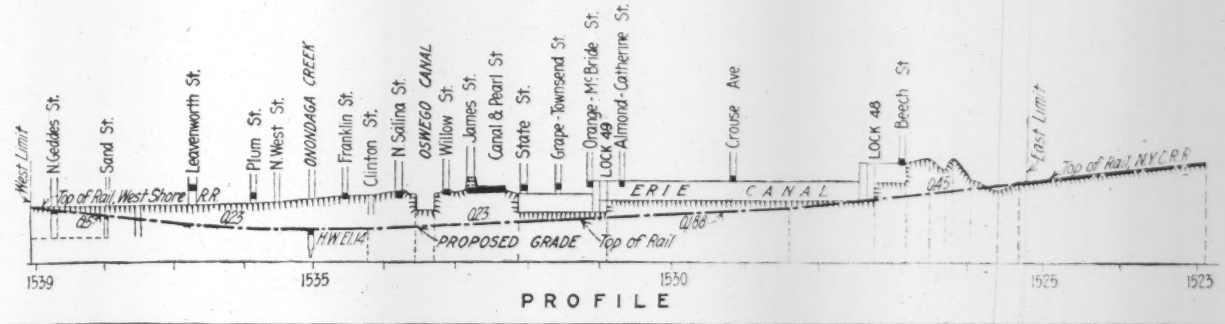
FIG. 1. RAILROADS, CANALS AND PRINCIPAL STREETS OF SYRACUSE AS THEY ARE AT PRESENT

ing made of the Arnold plan, and that if certain problems, some which will be mentioned later, can be solved the company is not inclined to oppose the scheme.

For an understanding of the magnitude and complexity of the Syracuse problem it is necessary to study the railroad and street map of the city (Fig. 1). East and west are three main transportation thoroughfares, roughly parallel and close together. On the south is the main line of the New York Central R.R., which for more than a mile occupies the grade of Washington Street, where all passenger trains proceed at slow pace past office buildings and residences, and school boys "flip" the Empire State Express. A quarter of a mile to the north is the West Shore R.R., which also crosses numerous streets, including some of the most important ones, at grade. The New York Central operates the West Shore, mainly as a freight line. Between the two roads is the Erie Canal, which some distance west of the business center crosses to the south side of the New York Central and the Delaware, Lackawanna & Western R.R. The latter, which is the Binghamton-Oswego branch, winding in from the south, crosses 18 streets at grade, comes to a parallel with the New York Central, and finally passes under it and the West Shore at the south end of Onondaga Lake.

Besides these main lines there is the Ontario division (formerly the Rome, Watertown & Ogdensburg) of the New York Central, running northwest from the main-line station, and involving four more grade crossings; the Auburn branch of the main line and the Chenango branch of the West Shore, which come in respectively from the southwest and the southeast near the city limits; the Syracuse Junction Ry., a detour to the north of the city for New York Central freight; the Salt-Lands spur of the Lackawanna from Onondaga Lake to the R. W. & O.; and the Oswego Canal, which branches from the Erie Canal in the heart of the city and parallels the R. W. & O. Of bearing on the situation also is the fact that the New York State Barge Canal passes north of Syracuse, a spur coming down through Onondaga Lake to a barge terminal in the Salt Lands.

The New York Central and the Lackawanna have separate stations, some distance apart, as shown. There is also a little-used station on the West Shore. The New York Central has freight houses, team tracks, a coach yard and switching yards west of its station. The Lackawanna has freight facilities near its station and along Fayette St. The West Shore has a freight house and other facilities from the business district east and the R. W. & O. has similar facilities along its line. At the



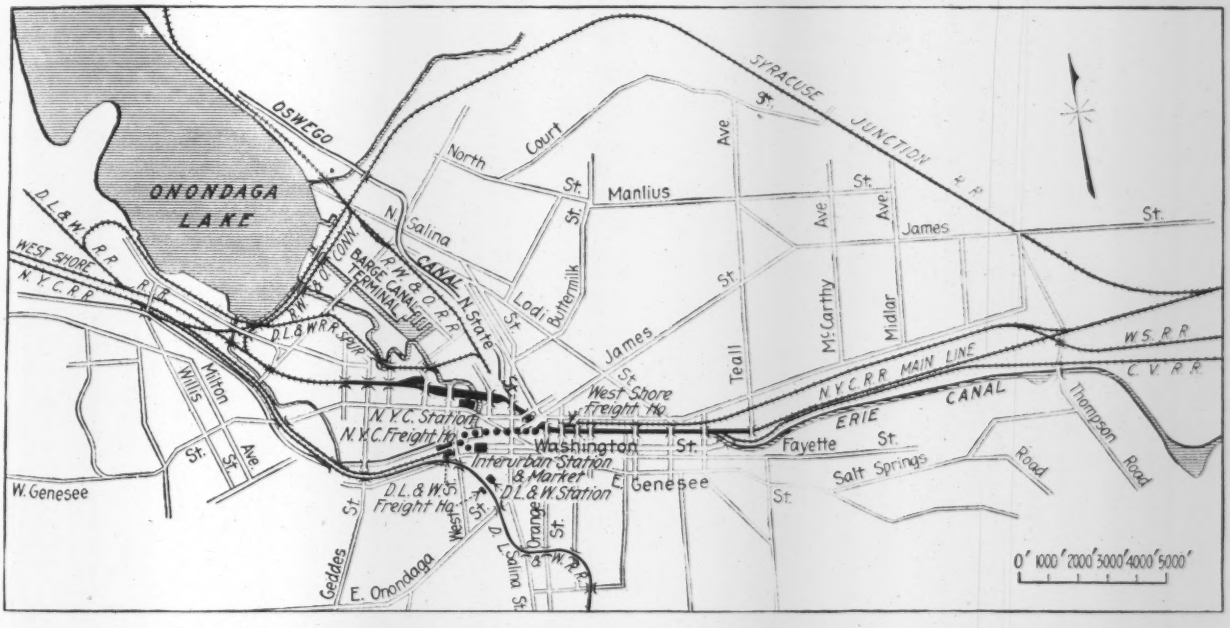


FIG. 2. PLAN RECOMMENDED IN ARNOLD REPORT FOR IMMEDIATE ADOPTION—LACKAWANNA ELEVATED, NEW YORK CENTRAL DEPRESSED IN CANAL BED

east end of the Syracuse Junction Ry. is the large De Witt yard, one of the division points of the New York Central.

In all, states Mr. Arnold, there are 73 grade crossings, besides 14 canal crossings that interrupt street traffic, that require consideration, this neglecting industrial tracks.

Three principal streets, Salina, Genesee and Onondaga, form a triangle and give the city what Mr. Arnold considers an excellent fundamental street system.

For the Lackawanna the solutions of the problem that have presented themselves call for either elevation or de-

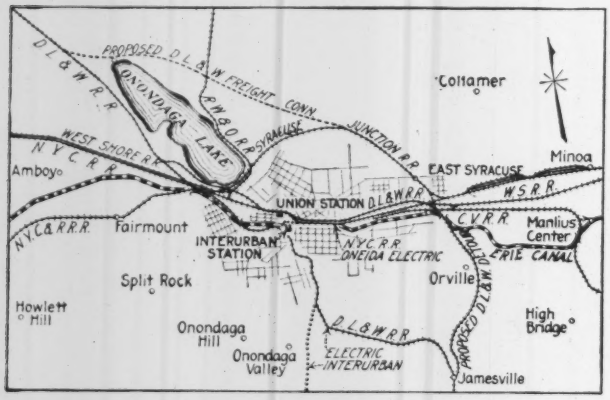


FIG. 3. IDEAL PLAN, WITH LACKAWANNA RELOCATED

pression of the tracks on their present right-of-way, or for the construction of a connection from Jamesville to one or another of the New York Central lines east of the city. As for the New York Central, it has been generally conceded that main-line traffic should be removed from the present main line, at least in Washington St.; and while other routes have been proposed, most consideration has been given to the alternatives of using the Erie Canal bed or the West Shore right-of-way. Doubt has been expressed in the past as to the feasibility or desirability of abandoning the canal as a waterway; Mr. Arnold, however, considers it feasible and highly desirable.

Reasons for Solution Offered

Elevation rather than depression of the Lackawanna is recommended by Mr. Arnold mainly because of the drainage problems that depression would introduce. He urges emphatically, however, that the elevation take the form of a viaduct from Orange to Fayette St., as he holds that a solid fill would be a barrier to the growth of the southwest part of the city. Preferably reinforced-concrete column-and-slab construction should be used, but if steel is used it should be incased in concrete and a ballasted roadbed should be provided to minimize the noise.

Depression is recommended for the New York Central because elevated tracks would place a barrier through a center of great traffic movement, and particularly because it would create a long and bad crossing at State and James Sts. and intrude an elevated structure on space considered ideal for a civic center. Utilization of the Erie Canal bed east of State St. is favored because it would both provide the right-of-way and eliminate a large amount of excavation. (There are two locks in this section of the canal, and there would have to be additional excavation.) If no supports are required between tracks for the bridges the canal right-of-way is wide enough for five tracks. West of Salina St., where the West Shore is more direct and desirable, there is room for seven main tracks, two of which can thus be assigned to the Ontario division, which as previously stated would parallel the Syracuse Junction Ry. along Onondaga Lake.

New Station for New York Central

Location of the station at West and Genesee Sts. permits of fifteen double-berth through tracks, with the headhouse located symmetrically and the possibility of further expansion on the north side. This Mr. Arnold deems ample for many years to come

As previously mentioned, this plan would retain the present New York Central station as a terminal for the numerous interurban electric lines that radiate from Syracuse, but as the station is larger than would be needed Mr. Arnold thinks a public market could also be established for the property.

The New York Central would retain its freight yard with entrance from the west, and the West Shore would retain its east-side facilities.

Fig. 2 shows the railroads as they would appear under the recommended plan.

The New York Central's Views

One of the chief criticisms of this plan from the New York Central point of view comes at a point where Mr. Arnold finds the West Shore elevation scheme objectionable, namely at James and State Sts. As this is along the edge of the contemplated civic center, Mr. Arnold would cover the tracks for a distance of about 500 ft. The New York Central points out that from the operating standpoint this would be particularly undesirable because the covered trackage would be practically at the east throat of the station yard, where there would be a large amount of switching. The company is making a thorough study of the somewhat awkward problem presented by a train-yard approach on a reverse curve and bridged by several streets.

Another matter the company is considering is the location of the R. W. & O. connection, to bring it over the Salt Lands rather than alongside the Syracuse Junction Railway.

Still another point is the financial adjustment. The company already owns its West Shore right-of-way, and feels that it should not be put to extra expense acquiring the bed of the Erie Canal.

Ideal Plan

In the so-called ideal plan, which Mr. Arnold thinks the future may justify, depressed tracks would be laid both in the Erie Canal bed and on the West Shore right-of-way from Salina St. east, thus accommodating the New York Central, the West Shore, the Lackawanna (brought in by the detour that would be built from Jamesville) and the Utica & Mohawk Valley electric line. All New York Central lines could take the West Shore, leaving the canal bed to the Lackawanna and the electric lines. (The report points out that it would be easier to get the Lackawanna across to the north side if the New York Central would share the canal bed with the electric railway and let the Lackawanna go with

the West Shore; but the New York Central would hardly look favorably on this idea.) On the basis of the ideal plan the Lackawanna would swing to its Salt-Lands spur just west of what would be the union station, and all of its traffic could take that route. If the growth of the Lackawanna freight traffic warranted, however, an overhead connection could be made to the Syracuse Junction Ry., which would be followed around to the Salt-Lands spur; or another cutoff north of Onondaga Lake could be built.

Fig. 3 shows the possibilities of the ideal plan. The New York Central and the Lackawanna would retain their local freight facilities with entrances from the west. The West Shore would have to replace its facilities. The Washington St. tracks would be removed. Practically all other railroad and canal right-of-way released would be utilized as entrances for interurban electric lines.

Other Plans Rejected

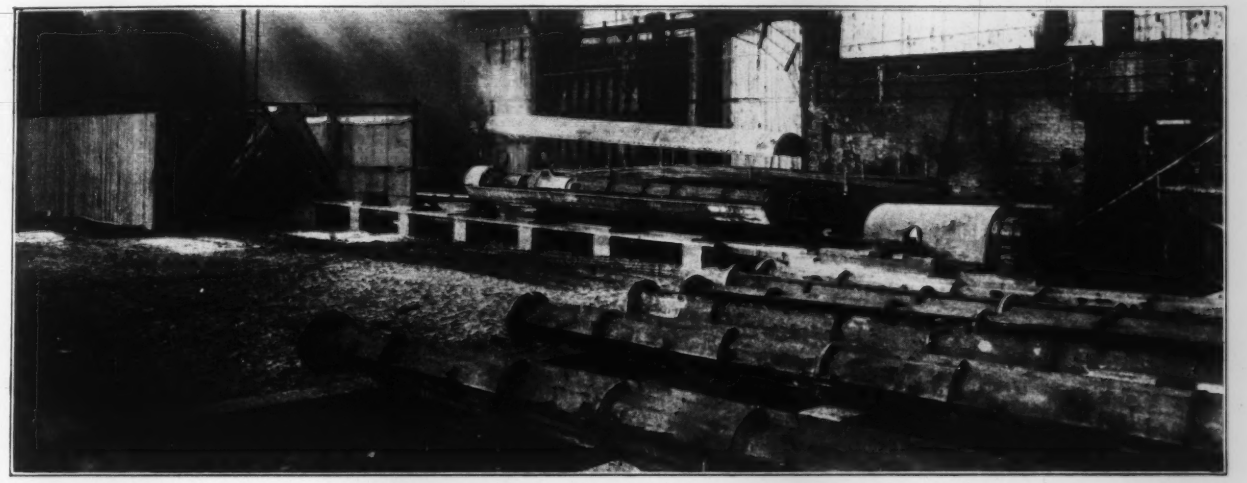
The plans rejected wholly or in part by Mr. Arnold show the wide range of solutions that have been offered by influential citizens or organizations to the problem. There are plans which use an elevated West Shore and place the station east of State St. (As previously stated the New York Central has itself contended for such a plan.) These plans Mr. Arnold finds faulty because of the barrier they create and the lack of space for a suitable station. Other plans divert all passenger traffic to the Syracuse Junction Ry., swinging it in around the Barge Canal terminal in what is considered a vain attempt to get the station near the business center. There are plans for tunnels under the high ground north of the West Shore and east of James St., but Mr. Arnold will not consider tunnels unless electrically operated, and thinks electrification not feasible at this time. There are depression plans for the Lackawanna, the objections to which have been stated. And lastly, there are plans for union or contiguous stations for the New York Central and Lackawanna, accomplished by swinging the former over to its present right-of-way west of the business center and locating the station or stations at Fayette and West Sts.; but these Mr. Arnold rejects because they sacrifice accessibility and over-emphasize the importance of union stations.

As to the matter of electrification, Mr. Arnold thinks whatever plans are adopted should contemplate the ultimate electrification of the main line of the New York Central through the city. At the same time he points out that it would be entirely unfeasible to bring this about until the entire operating division of the railroad, which is now from East Syracuse to Buffalo and is likely to be from Utica to Buffalo in the near future, is electrified.

Concrete Poles Now Made Here by Centrifugal Process

European Method of Making Concrete Poles by Turning Filled Mold in Giant Lathe Introduced in United States

SOME years ago there was brought out in Europe a method of manufacturing concrete members, notably piles and poles, by a centrifugal process which in effect consisted in partly filling a long cylindrical mold with concrete and whirling it around its longitudinal axis until the concrete had been forced into a hollow cylinder. A similar process has been put on a commercial basis in this country by the Universal Concrete Products Co., of Chicago, which is now engaged in the manufacture of poles and which has in contemplation the manufacture of hollow piles made by the same method.



CONCRETE POLES ARE MADE IN THIS PLANT BY FILLING THE FORMS AND WHIRLING IN THE GIANT LATHE

The plant where the poles are made is shown in the accompanying view, and the method is described as follows by W. H. Lienesch, chief engineer of the company.

Metal Form Placed on Rollers

The lower half of a circular metal form is placed on rollers set in line with a special machine, which is constructed so as to revolve the form in a horizontal position. This half-form is filled with wet concrete material, a fabricated cage of reinforcing steel is put into the concrete, the upper half of the form is placed in position, and the entire form, concrete and steel, is rolled into the machine. Special clamps in the machine are used for the purpose of holding the halves of the form together. After the form is securely clamped in place, the machine form, with the concrete and steel, is

revolved for a period of several minutes at a high rate of speed. During this action the centrifugal force that is developed from such speed causes the concrete to be compressed against the inside of the form with a pressure varying from 75 to 300 lb. per sq.in., producing a dense concrete structure having a smooth hole through the center and walls tapering in thickness from end to end of the pole.

During the mechanical action of this process, air bubbles and other voids tend to be eliminated from the plastic mass of concrete, and the water is caused to flow toward the center and is finally expelled from the pole by pouring out of the large end through its own gravity. It is claimed that the immediate elimination of a great percentage of its moisture causes the plastic material to set up into a firm body that bears considerable rough handling before the initial set takes place in the cement.

Immediately after the pole is turned it is removed, in the form, from the machine and allowed to set for 12 hours, after which the upper half of the form is taken off and the finished pole is rolled out of the lower half into a bed of fine sand. The pole is then allowed to harden for 96 hours, at which time it is sent to a storage yard and is ready for shipment after being cured under water for a period of 10 days.

Reinforcement in Proper Place

The forms and steel cages of reinforcement are so constructed that the steel is retained in its figured position, being in the center of the concrete wall at the pole top with ½ in. of exterior concrete protection along the entire pole length. The steel cages are woven in a special loom that accurately spaces the longitudinal bars about the perimeter of the cage and winds them with an exterior spiral of steel wire having a varying pitch that is closest at the base of the cage. The use of numerous small units of steel, some of which are stopped off at various points along the length of the pole, permits the graduation of sectional area from a minimum at the top to a maximum at the ground line. The weight of a properly designed round hollow centrifugal pole is 50% less than that of any solid concrete pole of equal strength and only 2½ times that of the best cedar poles, which have only one-half the strength of the concrete pole.

Camp Buildings Finished in 12 Days by Joint Work of Contractors, Army Officers and Civic Bodies

At Fort Oglethorpe, Georgia, 136 Wooden Buildings Were Erected in Only 12 Days—Motor Trucks Haul Lumber

CONSTRUCTION efficiency aided by civic patriotism made record work of the job of building the wood cantonments for the Officers' Reserve Corps Training Camp at Fort Oglethorpe, Ga. On April 20, Major Edward S. Walton, commanding officer of the 17th Infantry, stationed at Ft. Oglethorpe, received instructions from the War Department to begin immediate construction of the reserve officers' training camp to accommodate 2500. Simultaneously with the preparation of bills of material and the selection of a site of the camp in Chickamauga Park contractors and dealers in lumber and building material in Chattanooga were notified of the impending construction and urged to cooperate. The Manufacturers Association, the Chamber of Commerce, the Builders Exchange and the Engineers Club of Chattanooga responded to the call and in a mass meeting held for the purpose determined to combine all local resources and assist the Post Commandant in getting the job done on time.

One Contractor Handles Buildings

The time limit for completion was set for May 7. Analysis of contractors, bids received Saturday afternoon, April 21, indicated that the job could be best handled by one general contractor for the building work and allotting the roofing, plumbing and lighting to dealers and small contractors. The award for the building construction was placed with the T. S. Mondy Co.; T. W. Knight was employed by them as general superintendent.

The site of the camp is on Snodgrass Field, ground made famous by General Thomas, who made his stand there in '63. The camp lies about 10 miles from Chattanooga, the nearest point of material supply. The route of delivery was over good pike roads. All material used in building operations was transported from the city to the camp by motor trucks.

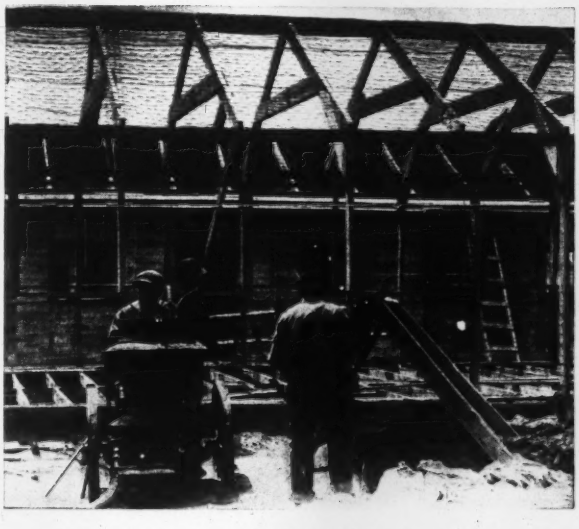
On Saturday night, April 21, the lumber yards, the various dealers in building material and the labor organizations were advised what would be expected of them, and on Sunday, while the work was being laid out, over 110,000 ft. of lumber was delivered to the job. The work as then contemplated consisted of 81 buildings made up as follows: 15 barracks each 20 x 245 ft. in plan; 15 kitchens each 20 x 28 ft. in plan; 15 mess halls, each 20 x 84 ft. in plan; 16 bath houses, each 9 x 28 ft. in plan; 16 latrines, each 9 x 35 ft. in plan; 1 hospital, 20 x 126 ft. in plan; 1 administrator building, 20 x 98 ft. in plan; 2 storehouses, each 20 x 56 ft. in plan.

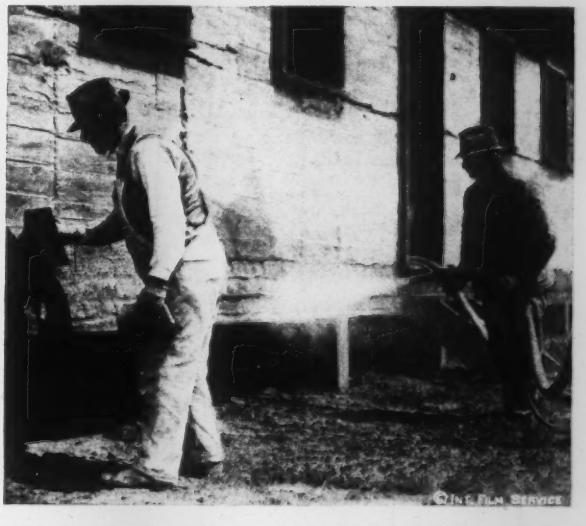
Timber Delivery Rapid

The rate of progress was such that daily delivery of lumber amounting to 100,000 ft. was erected as fast as delivered. Extreme difficulty was encountered in obtaining the grade and amount of flooring and boxing required, but the lumber yards of nearby towns were combed to obtain it and delivery was accomplished by motor truck.

All structures were under roof within 9 days of the start of the work and the original order was practically completed in 12 days. Additional building units such as officers' quarters, officers' mess, negro bunk and mess houses, hand baggage and trunk storage, quartermaster depot, garage, stables, bath houses and latrines, were added from time to time during the original construction period. All of the 136 buildings were completed May 9. While this feat is regarded as an achievement for which

Speeding Up Building Construction at Officers' Training Camps





At training-camp sites throughout the country every effort is being made to rush work on the wooden buildings to house reserve officers during their period of preparation for actual field service. The article on the preceding page tells of the speedy job done at Fort Oglethorpe, Ga. The accompanying photographs illustrate some of the construction details of the camp buildings at Fort Myer, Va. Next week's issue will give further information on camp buildings. It will be noticed that the cement gun is being used at Fort Myer.

Chattanooga may well be proud it was made possible by the thoroughgoing and practical manner of handling the work by Major Walton and his staff, for the army officers, and by Mr. Knight for the contractor.

Now that the Army Draft Bill has become a law it seems probable that thirty-two concentration camps will be established calling for a vast amount of building construction similar to that described in this article.

Trouble Calls in Meter Department

Of 7478 metered services in Oak Park, Ill., a 100% metered city of 32,000 population, 62.5% required calls for troubles, inspections or other reasons during 1916. The following are some of the reasons and percentages of the total requiring attention: Delinquents, 8.2; accounts closed, 6.6; new customers, 6.8; investigation for leaks on account of high bills, 4.6; meters not registering, 7.2; original tests of meters, 9.5; water complaints, 1; meters reread, 1.7; meter leaks, 3.2; service leaks, 0.8; meters read for new tenants, 2.6; repair meter dials, 0.5.

Of the 1482 meters brought to the shop for repair and test, 12.41% were damaged by heat; 5.74% were damaged by frost; 8.23% had disks broken by foreign particles or by water hammer; 6.21% had the disks stopped by obstacles, but not broken; 1.36% had the chambers (only) sprung by foreign particles; and 2.63% had miscellaneous damages to gears and pawls. All these things caused the meters to stop registering. Other reasons for shopwork were 10.12% for meters removed and replaced by others, 4.79% for meters tested at request of consumers, and the remaining 48.51% were for old meters not previously tested.

Will Combine Mohawk and Sector Types in Genesee River

Movable Structure To Be Built at Rochester in Connection with New York Barge Canal Harbor Work

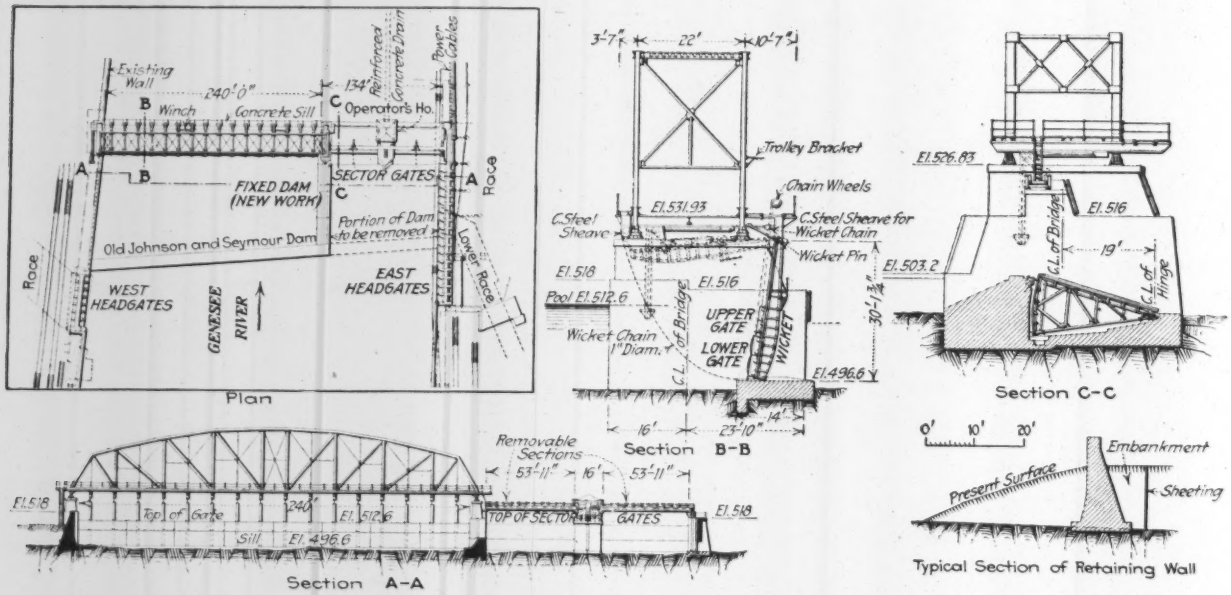
A MOVABLE dam, made up of a combination of the sector type and the Mohawk River type developed by the New York State Barge Canal engineers, will be erected this year on the Genesee River at Rochester, N. Y., in connection with the Barge Canal harbor there. The dam will be used not only to afford a proper depth for the harbor and bring about a level crossing of the canal and the Genesee River some miles upstream, but will also serve to relieve during flood times the obstruction in the river which would be caused by a permanent dam of the same type.

It is to be built just downstream from the present low Johnson & Seymour dam, which as shown on the accompanying drawing is to be removed on one side of the river and the section turned so that it leads into the pier between the movable dam and the sector gates during normal water stage. The control will be entirely by the sector gate. Any stage high enough to pass the present low dam will be transferred to the larger dam.

The sector-gate section is about 124 ft. long, about one-third of the length of the dam. It consists of two sector gates, each 53 ft. 11 in. long, separated by a 16-ft. pier. These gates are operated by hydraulic pressure obtained from the impounded water.

The so-called Mohawk bridge dam, which comprises the remaining two-thirds of the structure, consists of eight sections, or gates, supported from above by a heavy steel truss bridge. A complete description of this type of bridge dam appeared in *Engineering News*, Aug. 14, 1913, p. 283. Briefly, the dam consists of gates moving vertically upon uprights hinged to the bottom chord of the bridge and supported at their bottom, when lowered, against a masonry sill in the river bed.

The contract for this dam was let on Apr. 10, 1917, to the Combined Construction Co., of Rochester, N. Y., for $321,000. It is expected that contract work will commence as soon as the river is at its low stage, which ordinarily is in the latter part of June.



NEW DAM ACROSS GENESEE RIVER AT ROCHESTER, N. Y., IS TWO-THIRDS OF THE BRIDGE DAM AND ONE-THIRD SECTOR-GATE TYPE

Water-Filtration Progress to Date

Accomplishments by States and Provinces Summarized—784 Plants in 1917 as Against 50 in 1900

IN 1917 there were 784 water-filtration plants in the United States and Canada, as against only some 50 in 1900. This total includes only the 443 municipally and the 333 privately owned filter plants supplying municipalities and the 8 plants owned by the United States Government, thus leaving out of the count the numerous industrial, institutional and other isolated or private plants, which altogether must run into the thousands.

The rapid progress of filtration is further illustrated by the fact that the municipal filtration plants in use in 1900 supplied only 2,000,000 people, compared with the 10,000,000 supplied in 1910 and approximately 20,000,000 who are at the present time enjoying the benefits of filtered water.

The distribution of filtration plants in 1917 by states and provinces is shown by the accompanying table. It will be noted that the total filtration capacity included in the table exceeds 3,500,000,000.

As still another phase of filtration progress, the engineers mentioned call attention to the fact that some 20 years ago an average bacterial removal of 96% was considered fairly good, whereas now results are looked upon as somewhat suspicious unless the bacterial removal is

WATER-FILTRATION PLANTS IN THE UNITED STATES AND CANADA IN 1917

State or Province	—Ownership and Number— Municipal	Private	U. S.	Total	Population Covered	Total Capacity, Gals.
Alabama	6	5		11	250,000	27,025,000
Arizona		1		1	3,000	300,000
Arkansas	3	6		9	103,000	14,100,000
California	5	12	1	18	1,168,000	96,463,000
Dist. of Columbia	1			1	353,000	75,000,000
Colorado	6	3		9	271,000	62,475,000
Connecticut	3	3		6	175,000	31,000,000
Delaware	1			1	93,000	24,000,000
Florida	1			1	3,000	
Georgia	26	2		28	345,000	64,350,000
Iowa	11	10		21	276,000	53,700,000
Indiana	5	14		19	553,000	92,950,000
Illinois	15	21	2	38	481,000	112,050,000
Kansas	29	4	1	34	218,000	42,726,000
Kentucky	7	11		18	379,000	108,750,000
Louisiana	3	1		4	406,000	52,500,000
Maine	2	8		10	86,000	22,550,000
Maryland	5	5		10	631,000	141,850,000
Massachusetts	10	2		12	368,000	44,800,000
Michigan	4	5		9	235,000	54,410,000
Minnesota	8	3		11	380,000	62,928,000
Missouri	16	15		31	1,021,000	203,432,000
Mississippi	4	1		5	83,000	14,300,000
Montana	6			6	35,000	22,800,000
New Jersey	13	19		32	339,000	165,194,000
New York	41	20	2	63	2,859,000	198,194,000
Nebraska	1	1		2	6,000	600,000
New Hampshire	2	4		6	51,000	6,614,000
New Mexico	2	1		3	6,000	1,500,000
North Dakota	6			6	42,000	8,836,000
North Carolina	32	7	1	40	315,000	47,455,000
Ohio	40	10		50	2,025,000	510,055,000
Oklahoma	28			28	266,000	45,720,000
Oregon	5	5		10	33,000	12,618,000
Pennsylvania	19	80		99	3,436,000	860,361,000
Rhode Island	1	9		10	316,000	33,000,000
South Carolina	9	6		15	172,000	27,400,000
South Dakota	1	2		3	24,000	1,850,000
Tennessee	5	3		8	125,000	23,500,000
Texas	16	3		19	378,000	42,130,000
Vermont	1	2		3	30,000	4,570,000
Virginia	7	6	1	14	205,000	29,150,000
Washington	2			2	8,000	1,500,000
West Virginia	7	6		13	122,000	25,000,000
Wisconsin	6	5		11	176,000	38,950,000
Wyoming	3	1		4	12,000	6,115,000
Alberta, Can.	3			3	62,000	12,000,000
Manitoba, Can.	1	2		3	16,000	4,350,000
New Brunswick, Can.	1			1	7,000	2,000,000
Saskatchewan, Can.	4			4	40,000	10,400,000
Quebec, Can.	10	7		17	539,000	166,250,000
Totals	443	330	8	781	19,545,000	3,659,771,000

over 99%. Furthermore, 15 to 20 years ago it was not unusual to hear of 6% of filtered water being used for wash purposes, while from recent tests made by R. E. McDonnell the wash water required hardly ever exceeds 1%. These wash-filter figures, of course, relate to mechanical filtration plants.

The accompanying statistics regarding the status of filtration in 1900 and 1910 have been supplied by Burns & McDonnell, consulting engineers, Kansas City, Missouri.

Dry Rot Sometimes a Menace in Dry, Warm Timber Buildings

Some Examples of Wood-Frame Mill Constructed Buildings Where Dry Conditions Did Not Prevent Fungus Decay

By J. NORMAN JENSEN
Architectural Engineer, Chicago

FUNGUS growth in timber in contact with the ground or alternately wet and dry is an expected danger and one that is usually guarded against, but there are frequently instances of dry rot in structural timber inside buildings where conditions are apparently anything but favorable to such growth. Several such instances that have come under the writer's observation seem to be worth noting.

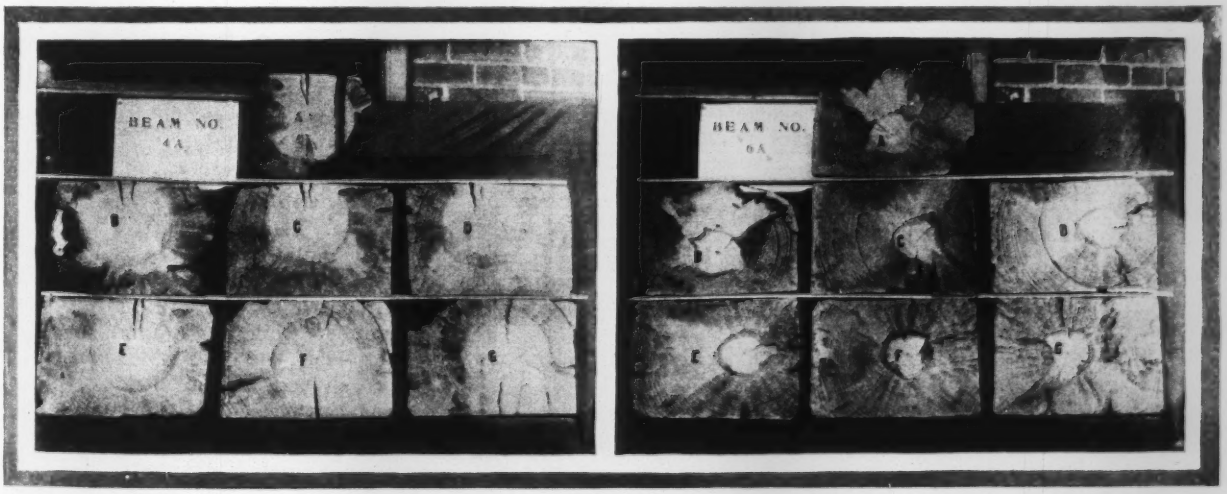
Floor Sags

In some of these cases a mill-constructed floor was directly over a boiler room. The first sign of failure was the gradual sagging of the floor, which in time became so out of level that the tenants were alarmed. An investigation showed that the timbers were so completely rotted through that one could easily shove a knife blade through almost any part of the beam. These timbers had certainly an abundant opportunity to dry out, as they were within 4 ft. of the top of the boilers, where the temperature was very high. The moisture was practically negligible.

In another large manufacturing plant a portion of a floor of mill construction was built over a railroad track. These beams were subjected to the exhaust from a locomotive that occasionally passed this spot, but outside of this the beams were kept perfectly dry and free from excessive warmth and moisture. This floor failed, and an examination showed that the timbers were rotten to the core, although externally sound.

Mercantile Building Floor Badly Rotted

Perhaps the worst case is that of a mercantile building having solid wooden floors 6 or 8 in. thick spanning two heavy wooden girders. Built about five years ago, the structure should have given good service indefinitely.



SECTIONS CUT FROM TIMBERS IN DRY MERCANTILE BUILDING SHOW SIGNS OF DRY ROT

as the loads on the floor were very light and considerably less than the designed load. It was noticed that the beams were sagging, after a couple of years, and this sagging became so alarming that the owner decided to have an examination made of the building by an engineer.

On removing the floor and uncovering the girders it was found that the floor itself directly over the girder was infected with dry rot. In some cases the girders had rotted so badly that only a mere shell remained. A thorough examination disclosed the fact that the timber on all floors of the building was infected more or less. In some cases the beams were so weak that the floor could hardly carry its own dead weight, and it was necessary to replace them with new beams.

Infected Girders Greatly Weakened

Some of the beams taken out were of loblolly pine, others of long-leaf yellow pine. They were sent to a research laboratory for identification and testing. Photographs of two of the girders are shown herewith. Each photograph shows seven sections of the same girder taken at various parts of its length. On breaking these beams in a testing machine it was found that they had only about 10 to 50% of the strength of new beams of the same size and quality of timber.

A question of great interest was whether the fungi that had been destroying the timbers for five years were still alive. Cultures were taken by an eminent pathologist to determine this. It was found that the fungi were still alive and healthy.

On some floors the girders were sealed up with ornamental plaster; on other floors they were bare. All floors were affected. None of the floors were damp, nor was the basement. The occupancy of the building was such as to prohibit any dampness. The building was heated most of the year. None of the things usually given for the cause of dry rot were there, yet the building was infected.

Too many good mill-constructed buildings, still sound and carrying their loads, have been built in the past to say that the foregoing cases are typical of this type of construction. In the earlier days a superior type of pine was furnished, which naturally could resist any fungus attacks. Lately, however, the market has been flooded with a grade of timber that is of uncertain strength and durability.

It seems to the writer that the foregoing clearly indicates that some treatment of building timbers should be applied, if we are to make sure of guarding against the ravages of dry rot.

South American Rainfall Reverse of Northern Pacific

Chilean Records Show Precipitation Increases from North to South and from Coast to Mountains

BY C. G. NEWTON
Seattle, Wash.

LITTLE is known definitely in the United States about South American rainfall. But the growth in number of American firms becoming interested in mines and towns requiring hydro-electric power service has produced a demand for such knowledge. The appended data on Chilean conditions are offered for the purpose of supplying part of this need.

Rainfall Diagrams

The Government of Chile has a system of rain-gaging stations similar to those in the United States. The data given on the accompanying diagrams are abstracted from the Chilean Government report for the year 1912, with the exception of the rainfalls at the Braden Copper Co.'s mill and hydro-electric plant.

Fig. 1 gives a map of Chile, with the rainfall for 1912 shown for the individual gaging stations. It visualizes the increase in precipitation with southern latitude. One peculiarity is to be noted: The fall for Station 8, Christmas Island, situated some distance off the coast, is much greater than for the coast opposite. Fig. 2 shows the increase in precipitation with the distance inland. This is due, of course, to rise in altitude for the same latitude. The Santiago figures need little comment, except that they go back 93 years and disclose the dry-year cycles. Rancagua is the terminus of the Braden Copper Co. branch railroad from the Chilean Government line. "Coya" is the name for the location of the Braden company's hydro-electric plant, and at "Molino" is the mill.

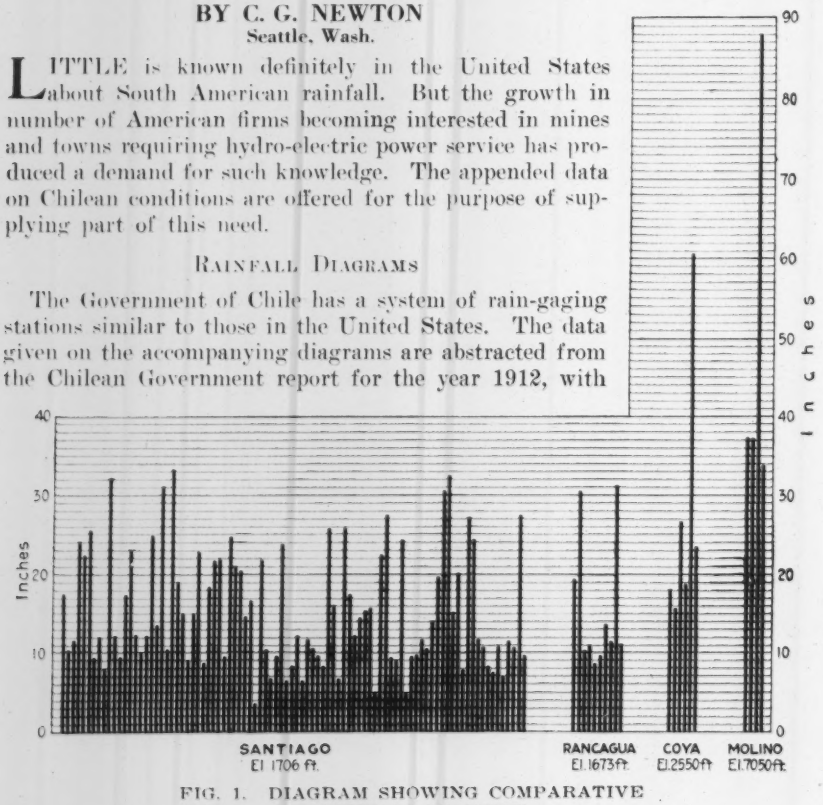


FIG. 1. DIAGRAM SHOWING COMPARATIVE RAINFALL IN CHILE

The rainfall of the west coast of South America from Paita, Peru, to Punta Arenas, Chile, is an almost exact parallel, in reverse order, to that of the North American coast from Lower California to Copper River, Alaska. The upper part of the coast from Paita, Peru, down, has very little rain, sometimes years passing without a shower. In the northern part of Chile the rainfall becomes noticeable, but is confined to one or two showers a year, the rest of the year being cloudless. Farther south, there are regions favored with clouds of mist part of the year, but little rainfall. Toward Valparaiso the rain-

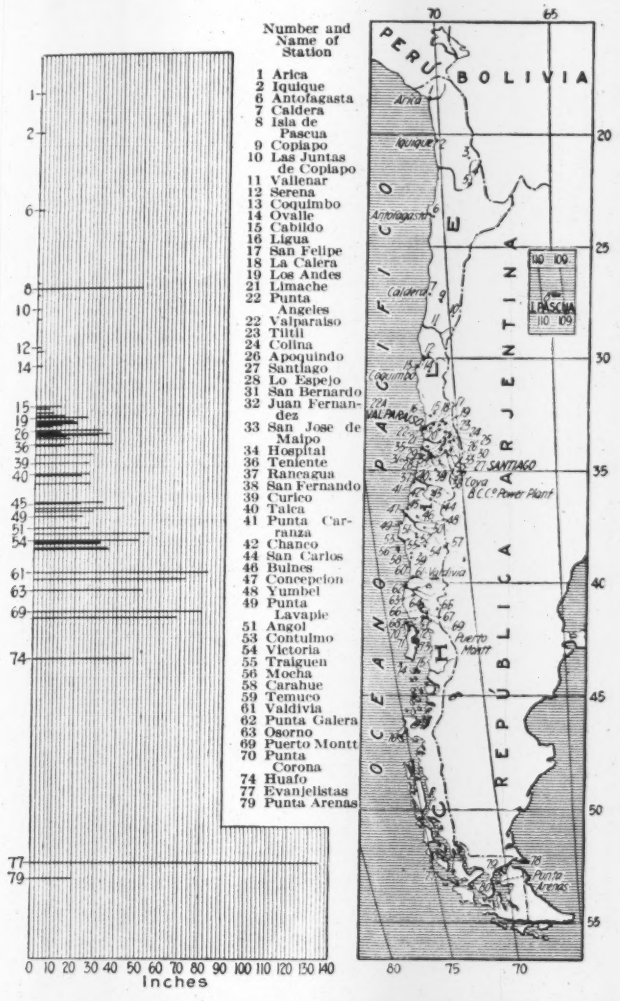


FIG. 2. DIAGRAM SHOWING TYPICAL CHILEAN RAINFALL FROM COAST TO MOUNTAINS

fall begins to increase and becomes steadily greater toward the south. Puerto Montt, the Seattle of Chile, has a considerably greater rainfall than Seattle. On the coast islands, west of Punta Arenas, the rainfall is similar to that on the Quillayute Peninsula, west of Seattle, and the coast islands of Alaska, being 135 in. at Evangelistas.

The whole coast climate is affected by the Antarctic current, which sweeps along it much as the Japan current affects southeastern Alaska. The traveler coming south of Paita, Peru, notices an immediate change from the heat of the tropics north of that point to a comfortable or even cold temperature south.

The rainfall affects Chile in similar fashion to the similar west coast of North America. The copper, tin and nitrate mines of North Chile and neighboring Bolivia must operate with a scant water-supply. The only agriculture is along the river bottoms, where irrigation is possible. Farther south, where the rainfall would make agriculture possible without irrigation, this is still prevented by the fact that the bulk of the rainfall is in the winter months. Consequently as far south as Concepcion, irrigation canals are used, fed by the summer floods of the rivers heading in the Cordilleran snow fields.

The south of Chile is a very wet, timbered country similar to Puget Sound. And the inside channels, south of Puerto Montt, are similar to the inside channels from Seattle to Skagway, being passages between timbered islands, on one side, with a timbered country sloping up to a snow-capped Cordillera on the other. The country around Punta Arenas is grassy, wind swept, foggy and largely used for sheep ranching.

From the Aconagua River, a short distance north of Valparaiso, south to Puerto Montt, there are many large rivers, with plenty of fall, heading in the Cordillera, capable of furnishing an immense amount of power. Generally speaking, however, a good market is lacking. When foreign capital comes in to develop the resources of the country in mines and timber and to promote irrigation, for which there is abundant opportunity, as well as for manufacturing industry, this water power will be a very valuable asset.

General data as to the rainfall in Chile and river-flow data can probably be obtained by application to the Departmento de Obras Publicas, Santiago, Chile, S. A. The appended table gives the rainfall by months for seven years at the Braden hydro-electric plant.

RAINFALL (INCHES) AT THE BRADEN COPPER CO. HYDRO-ELECTRIC PLANT, COYA, CHILE

Month	Year						
	1910	1911	1912	1913	1914	1915	1916
January							1 00
February						0 18	
March						0 08	1 93
April		2 68	3 34	0 03	0 84	3 62	0 12
May	0 30	1 24	7 01	3 87	4 42	10 08	1 60
June	7 70	2 55	9 60	1 64	14 86	4 27	1 12
July	7 50	2 25	0 40	7 44	10 42	2 87	3 83
August	1 80	0 88	4 93	2 74	9 15	1 28	1 99
September		2 21	0 75	3 21	9 58	0 44	2 20
October	0 40		0 23		6 17	0 62	
November			0 62		4 89	0 27	
December	0 60	3 94			0 25		
	18 30	15 75	26 88	18 93	60 58	23 71	13 79*

* To Oct. 28, 1916.

Interstate Drainage Causes Litigation

A drainage case of interest is before the United States Supreme Court for hearing on Apr. 23. North and South Dakota have filed a bill of complaint against Minnesota for trespass, due to the overflow of boundary waters alleged to have been caused by the construction of drainage works in Minnesota.

Lake Traverse, 17 miles long and 2 miles wide, and its outlet, the Bois de Sioux River, form the boundary line between the Dakotas and Minnesota. A drainage system built by Minnesota to drain state and other lands empties its waters into Lake Traverse through the mouth of the Mustinka River. The lower 7 miles of the ditch is in reality a straightening, widening and deepening of this river channel. The Rabbit River empties into the Bois de Sioux River 25 miles downstream (north) from the mouth of the Mustinka River.

The bill claims that this state ditch brings water to Lake Traverse in a relatively few hours that formerly took 12 to 20 days and also the overflow waters of Rabbit River, making the ditch the outlet of a drainage area of 750 square miles, causing the lake to rise 5 ft. above high water and to overflow 24,000 acres of land and a village in the Dakotas.

The complaint cites damages of $2,000,000 and asks that these be ascertained and judgment entered against Minnesota, and that a permanent injunction issue compelling the closing of the Mustinka ditch and the restoring of the river channel to its original regimen.

Intelligent Use of Road Oil Reduces Maintenance

Of Little Actual Value Unless Good Drainage Is Provided—All Soils Are Benefited, but the Gumbos Give Best Results

By T. R. AGG

Professor of Highway Engineering, Iowa State College, Ames, Iowa

USED first as a dust palliative for the unpaved streets of the towns, the excellence of the results obtained encouraged the belief that the application of oil would improve the rural highways. Users of treated roads consider them a marked improvement over the unoiled earth roads, but there has not yet been sufficient experience to demonstrate definitely the economic value of oil on earth roads. Where the work has been properly done and where the type of soil is favorable, the results obtained thus far are exceedingly promising; and if the road can be maintained at less annual cost by oiling than otherwise, the method is justifiable. While oiling cannot be considered a satisfactory substitute for a hard surface, the elimination of dust and the preservation of the surface resulting from oiling earth streets seem to be well worth the cost, so long as conditions will not permit paving. The soil is partly waterproofed, so that only in continued wet, cold weather will the surface become muddy. After the ordinary summer shower the roads dry quickly and suffer little damage from traffic.

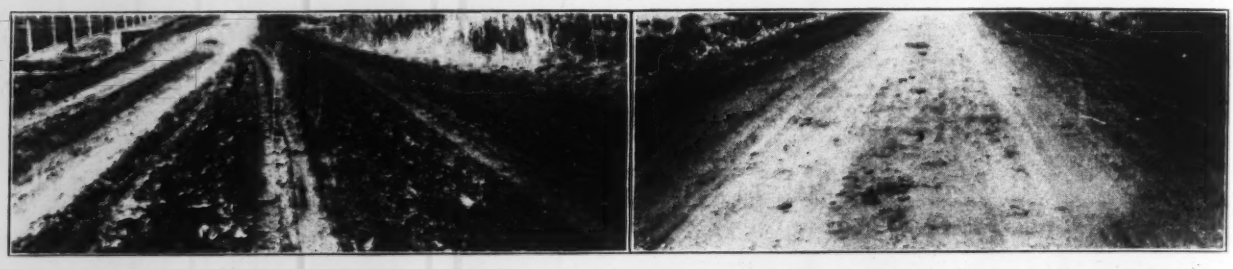
For the best results, oiling should be done early in the summer, but a second oiling late in the summer is advisable. In no case should streets be neglected after they have once been oiled, for the oily dust is exceedingly disagreeable and persists long after the beneficial results have disappeared. Though oiled earth roads and streets must be dragged to keep them smooth, they will not require as frequent going over as those that are not oiled.

Highway Officials Show Enthusiasm for Oil

An inspection of oiled streets and country roads was recently made in 10 counties in eastern Iowa for the purpose of ascertaining how the oiled roads had gone through the winter and to form an opinion as to the possibilities of this method of maintenance. Up to this time the winter and spring have been unusually dry for this state, and the earth roads, whether oiled or not, are for the most part in excellent condition. Highway officials in the various counties were enthusiastic over the results they had obtained with the use of oil, and nearly all the roads were in satisfactory condition at the time of the inspection.

However, the oiled roads had gone through the rainy period in the fall in much better shape than the roads that had not been oiled. Long-continued wet weather softens the surface of the oiled roads somewhat, and they become sloppy; but this does not affect the surface to a depth of more than a half-inch, whereas unoiled roads are softened to a depth of several inches. After a rainy period the oiled roads dry quickly and, if dragged at once, quickly become smooth and pleasant to travel.

In view of the comparatively slow progress that is being made in surfacing the earth roads of Iowa, as well as of other Western states, it seems quite likely that a good many of the more important earth roads will be maintained by oiling until such time as a more economical method is devised.



TWO HUNDRED FEET APART, THESE TWO SECTIONS DIFFER ONLY IN CHARACTER OF UNDERDRAINAGE

It is apparent that much better results have been obtained on some roads than on others, and a study of the types of oil, the manner in which the oil was applied and the condition of the road at the time of oiling points to some prerequisites for the best results with road oils.

The oils that have been most widely employed are petroleum products, known respectively as 50% asphalt road oil and 40% asphalt road oil—the best results being secured with the former. In very few instances have the oils been purchased under a specification, and the material as received has not usually been tested. A few samples have been examined in the Road Materials Laboratory at Iowa State College, and in general these were found to contain the specified percentages of residue of 100 penetration, although the character of this residue varied a great deal, as is shown in the accompanying table, which is characteristic.

	Sample 1	Sample 2	Sample 3	Sample 4
Specific gravity, 25° C-25° C.	1.01	1.01	1.00	0.91
Specific viscosity, 100 c.c., 50°C.	30.6	30.4	30.1	5.86
Loss on heating 5 hours, 163°C.	1.91%	1.67%	2.14%	14.8%
Residue from above	Sticky	Sticky	Sticky	Sticky
Total bitumen	99.8%	99.8%	99.9%	99.6%
Bitumen insoluble in 86° B. naphtha	9.28%	9.31%	8.46%	1.87%
Fixed carbon	6.5%	7.88%	7.13%	1.90%
Ash	0.07%	0.11%	0.00	0.089%
Flash point, open cup	407°F.	401°F.	396°F.	239°F.
Burning point, open cup	464°F.	457°F.	460°F.	284°F.

Note: Samples 1, 2 and 3 are "50% asphalt," while sample No. 4 is "40% asphalt."

The pressure rather than the gravity type of oil distributor is to be recommended because of the positive control of the quantity of oil applied and the uniformity of spreading. Preliminary heating in the tank-car facilitates handling and saves time if suitable equipment is at hand, but this is not usually the case. Under the conditions generally encountered in Iowa, the heating can most advantageously be done in the tank wagon while the load is being hauled to the road. The temperature should be at least 150° F., but need not exceed 200° Fahrenheit.

Useless To Oil Before Grading Road

The roads that are oiled before they have been properly graded and drained are usually little benefited. While the oil will in a measure waterproof the surface and turn the water to the side ditches if the surface has a good cross-slope, the oil treatment does little good if water stands on the traveled surface or in the ditches, or if underground water reaches the road surface.

The road surface that is suitable for oiling is smooth and dense and should be free from dust, which may prevent the oil from penetrating the roadway. If the oiling is done early in the season, dust will not usually be present in sufficient quantity to affect the results, but later in the season, during July and August, the earth roads are nearly always so dusty as to require that the surface be scraped or swept before oiling. In some instances, if the road be scraped free of dust and then sprinkled lightly with water late in the day, the oil may be applied the next morning and good penetration secured.

The quantity of oil applied at one spreading should not be so great that it will run off the middle portion of the road, and under proper conditions should not exceed ¼ gal. per sq.yd. After this has penetrated, which will be within 48 hours in hot weather, a second application may be made. If the application is carried out in this way, a minimum amount of the oil will flow off the traveled part of the road and be wasted.

The total quantity of oil should vary from ¼ gal. per sq.yd. of surface to about ¾ gal. The most satisfactory results have been obtained where ½ gal. per sq.yd. was used for a width of 8 ft., and ¼ gal. per sq.yd. for 4 ft. on either side of the 8-ft. strip—the oiling being repeated each year. This applies to rural highways, not to highways in the vicinity of the larger cities. Near the larger towns the roads need to be oiled, for at least a 20-ft. width, with ½ gal. of oil per sq.yd. of surface. It seems probable that better results might be obtained if a first application of ¼ gal. were made in June and a second ¼ gal. in the latter part of August or early in September, the road being covered for a width of 16 ft. the first time and 8 ft. the second time.

TOO FLAT CROWN HOLDS WATER AND MAKES RUTS

At first, annual oiling is necessary, but possibly after several annual treatments the quantity may be reduced or the oiling be omitted entirely for one year, though this has not as yet been definitely established by any experience in Iowa. The depth of penetration varies somewhat with the type of soil, but more especially with the quantity of oil applied. Roads were examined in many places, and the depth to which the oil penetrated ranged from ½ in. on dense soils, or on light soils that received a light application of oil, to 1½ in. on roads that had been oiled regularly for several years. The average for two applications of ½ gal. per sq.yd. in successive seasons was 1 inch.

OILED-EARTH MAT WITHSTANDS EROSION OF FLOOD WATERS

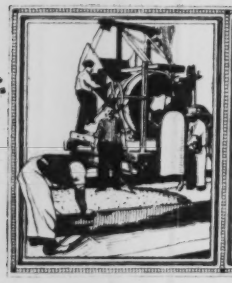
Oiled section ends at about center of picture. Untreated clay badly washed

The poorest surfaces are secured from the sandy soils. Fairly good results were obtained on the light clays and loams, but more oil was required than for the heavy soil. The best examples of oiled roads were on the type of dense, waxy clay known as gumbo. The oiled gumbo roads were almost entirely free from dust when inspected, but some dust was present on all the other types of soils. On the very light soils the amount of dust was sufficient to be disagreeable. An oiled road that has been allowed to get dusty is an unmitigated nuisance.

Oil Mat Resists Scour of Freshets

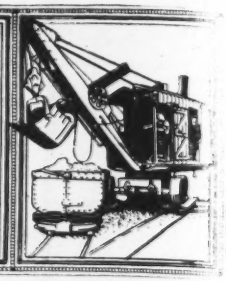
Some oiled sections of low-lying roads that had been under water during the spring freshets withstood the scour of flood waters remarkably well. In contrast to the adjoining sections of unoiled roads, the treated surfaces without exception were but slightly injured by the floods.

The road oils that had been employed in Iowa have cost an average of 3½c. per gal. in tank-car lots, freight included. Since the quantity of oil applied per square yard, the width of road oiled and the length of haul are all more or less variable, the cost per mile for oiling rural highways has sometimes been as low as $100 per mile and sometimes as high as $260 per mile. The price of oil has advanced 1c. per gal. this season, and on a basis of 4½c. per gal. for oil, a fair average cost for the application of ½ gal. per sq.yd. of surface will be $160 per mile. This does not include the cost of any work done in preparing the road for the oil. Some economy may be effected in handling the oil and the cost may be thereby reduced; but the quantity of oil cannot be reduced, and this constitutes about one-half the expense.



HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK



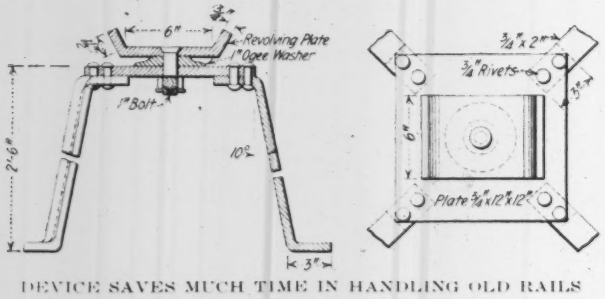
Small Turntable Cuts Cost of Handling Relay Rails

By JOHN H. SAWKINS

Jersey City, N. J.

THE TURNTABLE shown in the accompanying sketch is proving a big labor and time saver in handling rails for the new car-repair yard of the Pennsylvania R.R. now under construction at Greenville, New Jersey.

The 85-lb. rails used are second-hand, and the ball of each is badly worn on one side. Since it is therefore necessary to place the unworn side on the inside of the



DEVICE SAVES MUCH TIME IN HANDLING OLD RAILS

track being laid, it happens that many of the rails have to be turned end for end before placing them. Previous to building the turntable it required considerable maneuvering by a gang of at least six men to turn one rail. With the turntable, however, which is set up about 18 ft. from the track being laid, two men can turn a rail with ease. The device was made complete for $8.

Cofferdam Framed with Slotted Piles Used Successfully on Uneven Rock Bottom

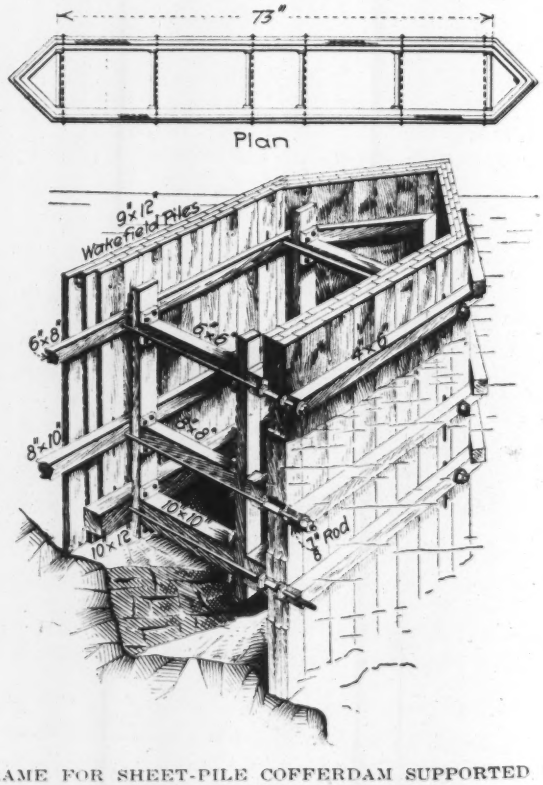
By KIRBY D. MACLEAN

Spokane, Wash.

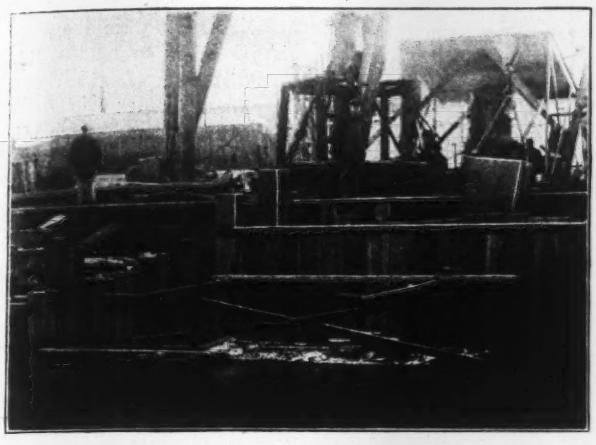
A COFFERDAM of Wakefield sheet piles, which was framed and put in place as a skeleton before setting most of the piles, was used successfully by the writer on the practically bare and very irregular rock bottom at the site of one of the piers for the new Division Street bridge in Spokane.

This bridge, which collapsed in December, 1915, with the loss of five lives, was being replaced with a structure 70 ft. wide and about 600 ft. long, consisting of three concrete arch spans with concrete viaduct approaches. The pier between the second and third arch spans was located in water which was 23 ft. deep at the lowest point, at low-river stage. Being only a short distance above the falls, there was a strong current at the bridge site. Soundings showed that the site of the pier was crossed diagonally by a vertical ledge, the bare rock at the downstream end of the pier being about 15 ft. below the water, while the rock at the upstream end, where the depth was greatest, was covered with 3 or 4 ft. of sand and fine gravel. It was planned to construct the pier on a concrete seal placed on the rock under water, and it was necessary to use a cofferdam because the irregular bottom made a crib out of the question.

The cofferdam, the skeleton of which was built in the water, towed to place and set before the insertion and driving of most of the piles, was made 2 ft. wider and 3 ft. longer than the base of the pier. Three layers of outside and inside waling, between which the sheeting fitted, were framed and spaced at the proper distance apart by bolting them to sheet piles placed at each cross-brace, 16 ft. apart. In these piles, through which passed the long bolts shown in the drawing, which held each layer of bracing together, were cut 1¼-in. by 4-ft. slots to permit driving them after the dam was placed. So that they would not bind after the frame had been drawn tight with the long bolts, 1-in. pipe sleeves, ½ in. longer than the thickness of the pile, were placed around each end of each long bolt in these slots. These sleeves, bearing against plate washers inside the rangers, prevented their being clamped tightly to the pile. The rectangular part of the frame was 12 x 73 ft. inside the sheet-



FRAME FOR SHEET-PILE COFFERDAM SUPPORTED BY DRIVING DOWN SLOTTED PILES



PENETRATION BEING SLIGHT, COFFER WAS WEIGHTED TO KEEP IT ON BOTTOM

ing, but the total inside length of the cofferdam was 89 ft. on account of the two pointed nose sections.

In addition to the posts shown in the drawing between the three tiers of bracing, the frame was X-braced for its entire length in a vertical plane, and each layer was also X-braced with 2 x 6-in. planks.

Pile bents, braced above and below water, had been driven out to the site of the pier for construction purposes and to serve later as a support for the arch centering. Extending the entire length of the pier and about 3 ft. from it, this falsework afforded a good anchorage along one side of the dam. On this falsework was a large stiff-leg derrick. The frame was moored and held plumb by the derrick while being weighted with bags of sand until it grounded on the downstream end. The upstream end was weighted to float level with the lower end, after which the slotted piles were driven, where the 4-ft. slots were long enough to permit it, to a bearing. These piles were then bolted securely to the frame, serving as legs to hold it in place while the remaining Wakefield piles were set around it. Special piles were made where necessary to secure tight closures.

When all the bays were filled, the piles were driven to rock with a drop hammer, handled in swinging leads by the derrick, and bolted to the frame, more weight being added to overcome the increasing buoyancy. The piles were built up of 3 x 12-in. plank, surfaced one side and one edge, and were dry when placed, so as to swell tight. The only openings were now the slots, the irregularities on the bottom, and in some cases a hole as much as 3 or 4 ft. high where the slots did not permit driving a pile to bottom. The large holes and slots were boarded up by a diver.

The sand in the upper end of the pier was then removed with a 6-in. steam-driven centrifugal sand pump, mounted so that it could be moved from place to place in a few minutes by the derrick. The diver worked on the bottom and handled the suction of this pump around until the rock was thoroughly cleaned off. All openings between the bottoms of the piles and the rock were then plugged with sacks of concrete by the diver, after which 325 yd. of concrete was placed under water in a continuous run to seal the structure. This was deposited in bottom-dump buckets to a depth of 10 ft. in the upstream and 5 ft. in the downstream end, leaving the surface of the concrete sloping from a depth of 10 ft. under water at the shallow end to 13 ft. at the other end. This seal embedded the lowest layer of bracing, the wales of which were outside the lines of the footing as designed and the braces of which were not required to be removed.

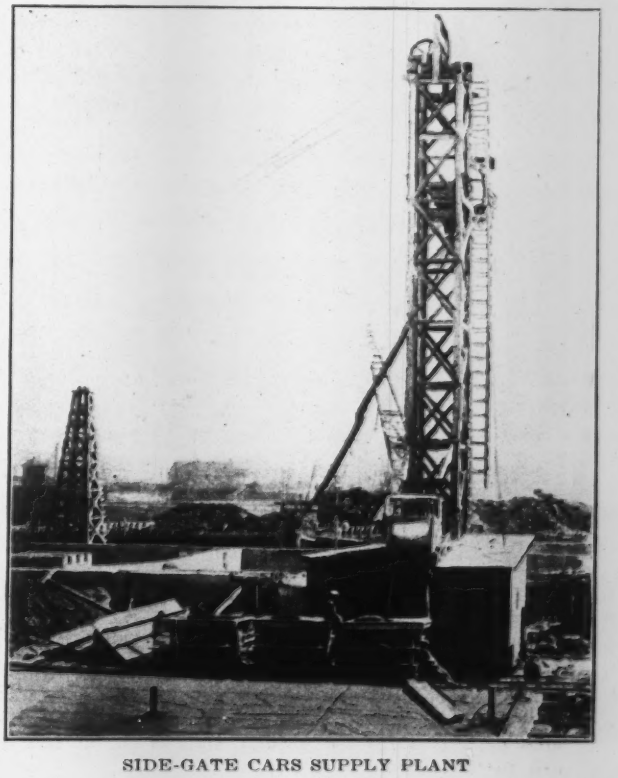
The cofferdam constructed in this way proved a cheap and efficient method of carrying out the work. It was built by the writer while engineer and general superintendent of construction for the Division St. and Olive St. bridges in Spokane.

Stationary Storage and Side-Gate Cars To Feed Traveling Tower Concrete Plant

THE advantages of charging the mixer by gravity and of having a traveling spouting plant of light weight at the same time are secured in a type of plant developed by the Dravo Contracting Co. for the construction of heavy industrial-building foundations, and being used on the work of that company at Sparrows Point, Md., described on page 385 of this issue, and elsewhere.

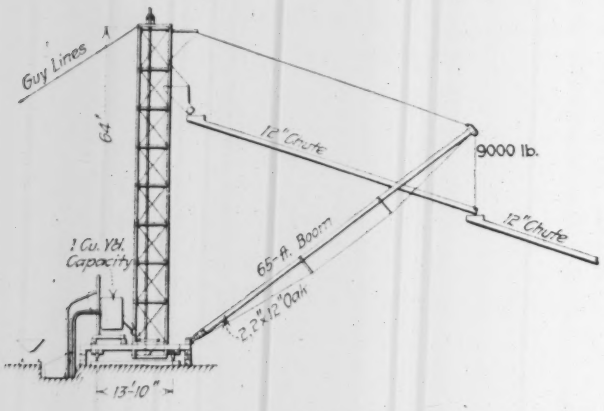
The one-yard mixer is set close to the ground and loaded by an elevating charging hopper. The trucks carrying the mixer, tower and hoisting engine travel on a track of the same gage as that adopted for this company's light revolving cranes. The plant, shown in the drawing, is light, and it can be easily moved with three or four parts of line by one of the Plymouth gasoline locomotives used to supply it with material.

To secure the advantage of a large storage near the center of the work being carried on, without requiring that the materials be wheeled to the mixer, loading hoppers and a stiff-leg derrick have been set up at the storage point selected for constructing the plate-mill foundations



SIDE-GATE CARS SUPPLY PLANT

at Sparrows Point. A large quantity of material can be stored on the ground within reach of the derrick, and the hoppers are used to load side-gate cars, made on the



TOWER CAN BE MOVED QUICKLY

work, each of which holds materials for one batch. These cars are transported to the mixer in trains of three or four by the gasoline locomotives. Two of the latter are employed.

The plant was designed under the direction of J. J. Nolan, of the contracting firm, while the work at Sparrows Point on which it is being used is in charge of J. S. Miller.

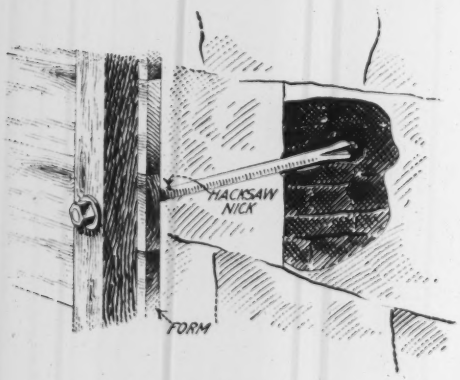
Anchor High Form to Face of Stone Retaining Wall

By SAMUEL WARREN

New York City

ANCHOR BOLTS were used as shown in the sketch to secure the form for facing with concrete an old retaining wall of dry masonry which was in such a location that there was no chance to brace the forms.

The wall, of dry masonry, supports a section of a railroad line that runs along the face of a cliff about 100



HIGH FORM ON CLIFF FACE ANCHORED TO OLD WALL

ft. high. The wall extends down to a ledge about 50 ft. below the track. This ledge was about 10 ft. wide outside the old stone wall, and the working space was still further reduced by the thickness of the new wall, which was 4 ft. at the bottom and 18 in. at the top. Except for the first few feet, there was no possibility of bracing the forms, and it was necessary to tie them to the existing wall. This was accomplished by making up bolts of ⅝-in. round rods, one end of each of which was split for about 2 in. to receive a wedge. Holes 5 in. deep were drilled into the stone for the old wall, into which the split ends of the rods, with small wedges inserted, were driven. After the rods were placed, the form construction proceeded in the ordinary manner.

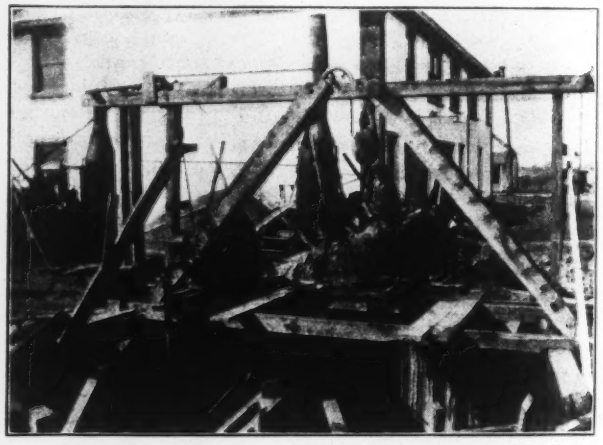
As it was impossible to remove the bolts after the forms were stripped, they were nicked with a hacksaw about 1 in. inside the face to facilitate removal. When the forms were taken off, a few sharp blows with a hammer knocked off the ends of the bolts inside the surface, and the holes were plastered up.

Concrete Mixer Hoists Pickle-Barrel Buckets To Sink Pump Well

By A. B. DEPUY, Jr.

Resident Engineer, Remington & Vosbury, Collingswood, N. J.

A DROP SHAFT 20 ft. in diameter and 20 ft. deep was sunk recently for a pump well for the sewer system of Bay Head, N. J., by the erection of a small gallows frame on top of the shaft, rigged as shown in the



LARGE SHAFT SUNK WITH CONCRETE-MIXER HOIST

photograph. A concrete mixer was pressed into service for a hoist.

The shaft was located in close quarters, and the headframe was used because there was no room to set up any sort of derrick. The walls of the well were concreted in two sections and sunk by excavating inside. Wet sand was encountered 3 ft. below the surface and continued for the full depth. It was hoisted out in two buckets made by sawing in two a pickle barrel and wrapping the halves with wire rope. The lead from the hoist line ran to a drum mounted on a Chain Belt concrete mixer. The material was dumped on a platform on top of the shaft and carted away in wagons.

The work was done under the direction of H. Gardner, superintendent for the Whiting-Turner Construction Co., of Baltimore, contractors. Remington & Vosbury, for whom the writer is resident engineer, are engineers for the sewer system in connection with which the shaft was sunk.

EDITORIALS

Contractor's Methods Save Stranded Submarine

NOT less interesting than the ingenious field methods used by the contractor in exhuming the 500-ton submarine "H-3" from her sandy grave on the California Coast, described on page 395 of this issue, is the lesson in administration taught by the job, and its bearing upon much of the emergency work which the Government is now handling. Failure to recognize this particular piece of salvage work as belonging to the engineering contractor rather than to the naval expert resulted in the loss of the four million dollar cruiser "Milwaukee" which was wrecked while trying to pull the submarine from the beach. Finally, when the attempt at recovering the vessel by marine methods had failed, an engineering contractor was rushed into the breach and saved the day. His job consisted essentially of passing cables under the buried hull, jacking up the 500-ton mass of steel, transferring it to rollers, and sending the vessel on a trip inland for repairs. The task of salvaging a beached submarine is not, happily, routine work. Nor are scores of other jobs which the war has presented for quick execution, routine jobs. The great need today, therefore, is for the executive who does not work by rule-of-thumb, or adhere slavishly to precedent, but who analyzes the task in hand and picks for each job the man or the method best suited to get results. If this method of selection becomes general the demand for men with either engineering or construction experience will be overwhelmingly greater than the supply.

Engineers for Engineering Work

WHILE many Government bureaus and departments have been reduced almost to a state of helplessness by the sudden load which has been placed upon them, faulty coördination arising from interoffice jealousies is not yet a thing of the past. All work has not yet found the hands best fitted to carry it out. Perhaps this is natural in a hubbub in which orders are given one minute and countermanded the next, and where department heads as well as subordinates are putting into their work too much action and too little thought. Time to bring about perfect adjustment has been lacking. But in one item, where engineers and construction work are involved, coördination should be perfected immediately. Now that the Army Draft Bill has become a law, the provision of living facilities at concentration camps for the new army requires quick construction of buildings on a vast scale—the creation, in fact, of thirty-two fair-sized cities, each with about 2000 buildings, in addition to sewerage systems, water supply and other improvements. The largest item in this work, involving six hundred million feet of lumber, is undoubtedly the construction of the buildings—primarily the work of the engineer and the contractor. And yet what do we find? Instead of being under the control of officers of the Corps of Engineers, the work is handled entirely by the Quartermaster Department which, it is understood, has extremely few engineers in its personnel. This condition of affairs should be remedied before the War Department commits itself to the extensive program of building construction now in sight. There should be closer coöperation than now exists between the Quartermaster Department and the Corps of Engineers, or, if that branch of the service is too overworked, with civilian engineers.

The City-Dweller and the Farmers' Road

THE Commercial Club of Corvallis, Oregon, must have among its members someone who realizes the value of rural roads, not simply as routes for rubber-tired pleasure jaunts, but in their relation to general business conditions. The contest described on page 387 could not under any stretch of the imagination be held to have been much of a benefit to tourists. Its results were measured in terms of days saved or made for commerce, for the scale of judgment was not placed against the actual condition of the road, but used to measure the improvement during the contest period. This is excellent doctrine, for while there is much road shouting, we detect among the sound waves too many vibrations that can be traced only to the Klaxon. After all, by far the greatest mileage of this country's roads is so distributed as to be of no great value or interest either to pleasure automobiles or to motor trucks, and unless attention can be drawn to the utter necessity of properly maintaining these roads, they are apt to be neglected in the frenzied search for the ideal permanent roadway. But when the cities realize that they pay, in the high price of farm produce, more of the penalty for poor roads than does the farmer himself, there will be many more contests such as the one described and a greater spirit of coöperation will be manifest between interests which so often seem antipathetic.

Grade-Crossing Problem at Syracuse

ALTHOUGH there are numerous cities throughout the country larger in population and area than Syracuse, N. Y., probably few present so complex a grade-crossing problem, so far at least as the New York Central system is concerned. The reason is that with three existing rail routes through or around the city, and an inviting canal bed to boot, there are so many possible combinations of these routes. The only certainties are that the Central must stop running its passenger trains in the bed of an important street, that elevation in this street would be unsatisfactory, and that a shift of these trains to another right-of-way will necessitate other wholesale shifts. The matter has long been under consideration, and some wild dreams have been put forth by various amateurs of local standing. Bion J. Arnold's report, abstracted on page 402 of this issue, summarizes the whole situation, makes definite recommendations and gives reasons therefor, and states why he rejects a score of other plans. A feature of his plan is his utilization of the byproducts by adapting released stations, rights-of-

way and canal beds for the use of interurban railways. Possibly, he being primarily a street-railway man, street-railway needs have colored his views of the main idea, but in any event his findings are well worth reading as suggesting broad treatment for such problems.

The Dublin Dam Contributes to Flood-Protection Science

EXPERTS may properly differ, and indeed do differ, as to the merits of the composite storage and flood-prevention features of the Dublin dam design, detailed on another page of this issue. But from a more general viewpoint the scheme enlists most appreciative consideration. A difficult public-works problem was so worked out—and it took some courage and a great deal of close study to do this—that two purposes, both necessary yet impracticable alone, were satisfied jointly and made financially feasible.

We say that the solution is a practicable one, in the face of the conservancy court decision at Columbus a few months ago disapproving the scheme, because complete proof has been given that Columbus will not be safe from floods without the Dublin basin, or else other construction of much greater cost. Engineers concerned in flood-protection should recognize clearly, if they have not already done so, that Columbus' present expenditure of several million dollars for channel widening is a large-scale delusion put into being in defiance of engineering counsel. It will cease to create danger, and will furnish protection, only when the retarding basin is also constructed. The fact that the Dublin dam is thus necessary justifies the belief that in time it will be built, and in our opinion that time is not very distant. When completed it will form the only, or at any rate the most ingenious, combined storage and retarding basin.

Perhaps the most novel structural element is the great 80-ft. outlet funnel, or circular weir, which is certain to engage the attention of water-flow specialists. How this weir and funnel will behave at different water stages is hard to predict. For the purposes of the present design, if we rightly understand the development of the plans, the critical flow conditions did not have to be considered. Sufficient guidance for the design was had from a clear appreciation of the operation at very low and very high heads—simple weir action in the one case and undisturbed outflow without surface effect in the other. Up to the level where the latter condition obtains, a circular hood masks the weir against approaching drift, the trouble-making factor in all similar flood-flow structures.

The successful combination of storage and detention depends on the operation of this funnel. Precise estimates of outflow and reservoir-filling would need for basis a close knowledge of its discharge at different heads. Not enough is known today concerning the flow in a drop-tube of these gigantic proportions to furnish reliable discharge figures at heads within the critical range. But the influence of uncertainty within this range is not large enough to produce material effect on the design for extreme flood conditions, that is, to affect the required height of dam or size of river channel very seriously.

That a duplex flood-retarding service is performed by the Dublin dam is likely to be overlooked when only the funnel and the storage-control valves are thought of. Yet in the duplex feature lies what is perhaps the most radical thought-element of the design. Small floods backing up in the lower part of the reservoir flow out through small openings near the base; only large floods, reaching the level of the circular weir, will discharge fast enough to overflow the farmed valley-bottoms. That the scheme will work seems plain; yet this addition of a third element to the combination of functions performed by the reservoir is bold. It is the point most open to doubt—doubt based on the broad principle that in emergency structures any complications of structure or of function are best avoided. But above all, one fact must be remembered: Only the favorable storage and channel conditions of the Scioto Valley make it possible to withhold part of the basin capacity from emergency flood service and devote it to other uses. The duplex or triplex reservoir feature is not of general applicability.

Analysis Supplants Mass Judgment in the New Hydrology

THE most uncertain element in water storage and water power engineering today is the most fundamental part—the estimation of water yields and flow rates. The trouble can be cured, for it is due to general lack of a real engineering attack on the problems of hydrology. Greater certainty of estimates of water yield can be secured than we are now obtaining; with this improvement will come diminished risk of investment in water-power, irrigation and water-supply projects. This will result in a true economy.

There are many who argue that a simple judgment, a mass weighing of the complex natural phenomena, is all that is here justified. No greater fallacy stalks today than this idea that lump judgment is more reliable than analysis of a complicated problem into simple elements, each of which may be judged in the light of what specific knowledge can be secured.

The case of hydrology is but one example—though a glaring one. It is worth studying here particularly because the art will shortly emerge from its dark stage and because *Engineering News-Record* has set itself to the presentation of the new work as occasion offers. A good example of what some engineers are doing is shown in the Horton evaporation formula presented in the April 26 issue—the biggest step forward since John Dalton wrote his equation 114 years ago. Some Eastern engineers treat evaporation studies in hydrology as piffling refinement, but that again is blind mass judgment, for evaporation loss in critical months anywhere may be much greater than the captured run-off.

Instances multiply: How many engineers consider the importance of the crops to be found in a drainage basin? A little study shows that sometimes 15% of the rainfall probably never reaches the ground. Corn land holds summer rains back, while wheat fields let them drain away rapidly. Again, in determining average precipitation in

a basin it is a common practice to assign weight to different rainfall records within and without the area wholly on judgment, whereas definite and logical rules are possible which eliminate the personal equation and mass judgment.

For instance, the relative weights assigned to precipitation records may be made proportional to the percentages of total area tributary to the record stations. Gaps in rainfall records may be filled in by interpolation, rather than by mere judgment.

Again, in respect to minimum yield of a basin—one of the most important figures that the hydraulic engineer is called on to estimate, in the absence of actual gagings on a given or similar adjacent stream—a logical method of calculation is available. If data can be secured that cover a period of ten to twenty days without rainfall, so that the supply to the stream from ground storage can be studied and the performance of the basin understood, the low-water yield can be deduced in very satisfactory manner. Those engineers who consider fragmentary gagings to be of little value would treat such a case by bulk judgment—guesswork—but they would lose in certainty and precision of result.

A reasoned study of data, as indicated for these specific cases, is capable of wide use, not merely in hydrology but in a great number of cases where now we tend to rely on sheer judgment. It is well to remember that the process not only gives deeper insight, but tends to balance the chance errors in the single elements of the problem.

Utility Managers and Commissions Face a Problem

A SERIOUS problem confronts utility managers and public regulating commissions just now: How, in this war emergency, can they give equally conscientious and equally prompt heed to the public interest as it has appeared heretofore and the newly created public interest? They must make far-reaching decisions quickly and be sure that they are right.

The important thing to bear in mind at the start is that the problem is not one of conflict between public and private interests. The real problem is to find what the public interest requires, what part of the requirements arises from temporary or emergency causes and what part from permanent causes.

Rates, hours of labor, character of service and all the other elements of interrelation between public and utilities bring up new and urgent questions. All appear under suddenly changed conditions, which would seem to call for leisurely study; yet the very nature of the case makes immediate decision a vital thing. The slow processes of adjustment used in normal times cannot be employed. Nevertheless it is even more than normally important that true and fair conclusions be reached.

Only by sudden mental growth and broadening on the part of the men who have to make these decisions can this almost superhuman demand be met. These men must employ new methods of reasoning, take a larger view of situations and interests, and in effect translate themselves to a higher plane of thought. *Engineering News-Record* is confident that a large majority of them will measure up to these expectations. The character-resources of our fellow-citizens engaged in public service have not been fully developed in the past. It is imperative now that they be developed.

But let the fact be well appreciated that it is easy to go wrong! Enthusiasm, hysteria and excessive public devotion may mislead, just as may venal self-interest. An almost extreme sanity of judgment must prevail. And it must be coupled with freedom from the hampering influence of precedent based on normal experience. We desire to make a plea for these qualities in engineer and lay citizen as well as in utility manager and in commissioner, for all of them are jointly concerned.

An instance will illustrate some of the difficulties of the new problems. Rate increases are asked by numerous utilities. Shall they be granted? We have been used to time-consuming studies and arguments in these matters, and the burden of proof has been on the side asking the increase. Under present conditions, where it is clear that every kind of expense has increased, and incomes are likely to drop rather than rise, shall the burden of proof be put on the other side? New studies seem essential, but time is lacking. Any imperiling of business stability is harmful now more than ever.

Or, as another instance, we have the laws and regulations built up for the protection of workers. Today we find the national administration taking the lead against these laws by abolishing the eight-hour restriction on certain classes of government work. Necessity, that is clear! There follow many others who also demand abolition of labor-protection, asking for example that all eight-hour regulations be abolished. Have they the same justification of necessity? True it is that we must all achieve higher efficiency and higher output without delay. Is a universal increase of hours of labor the answer? And immediately comes the next difficulty: How far shall we go? Shall no limitation be put on working hours—in other words, may the worker be divested of all that we have heretofore regarded as "protective" control? How much of this protection was founded on a valid argument of efficiency, and how much was based on merely general welfare reasoning? These questions are deeply serious, and decisions made now will remain with us far into the future.

Yet more uncertain is the basis for sound thought in the newer subjects of control of financing, regulation of combination and competition, and enforcement of provisions for general public safety and welfare. In respect to some of these the situation so suddenly developed might almost be expressed by stating it as a challenge from one quarter: All utility regulation ought to go out of business completely for the period of the war! And an answer from other quarters: The demands now made are merely attempts to take advantage of the stress of the times to secure general private objects.

There must be no creation, no growth of such violently opposing claims. The broadest spirit of wise judgment must control the decisions reached and the actions taken in this period. We look to utility managers, to commissioners and to the public for living up to this very high requirement. But our chief reliance will be on the managers and commissioners, that in a new-found wisdom and coöperation they may adjust every emergency with full success.

Longest Power-Cable Span To Cross St. Lawrence River

The demand for power in the Province of Quebec has risen to such heights (due to the manufacture of war munitions and various material not before produced in Canada) that the Shawinigan Water and Power Co., one of the largest power producers and allied with the Montreal power group, has been forced to undertake a record-breaking engineering feat—the spanning of the St. Lawrence River with a 100,000-volt transmission line. This crossing will be built about 1¼ miles above Three Rivers where the St. Maurice joins the St. Lawrence, and it will serve as an addition to the existing submarine cable crossings that furnish power and light to the asbestos-mining district of Thetford, the industries in Victoriaville, Asbestos, Windsor Mills and Sherbrooke. It will allow increased power to be supplied to the whole district south of the St. Lawrence.

A 5000-Foot Cable Span

The construction of this transmission line calls for the erection of two towers, which will support a 5000-ft. span of three steel cables. This span is the longest of the kind known, exceeding the 4427-ft. span across the Carquinez Straits in California. Towers will be necessary rising to the unusual height of 350 ft., the same elevation as the top of the Quebec Bridge. The height of the towers is fixed by the requirement of river navigation, the lowest point in the cable having to clear the water by 160 ft. minimum.

The towers rest on concrete foundations located in the river about 500 ft. from each shore. These foundations consist of four circular concrete columns, 11 ft. in diameter, extending to a depth of 40 ft. below the river bed and projecting 25 ft. above it, thus being partly submerged. The four piers are tied together above the water level by arched concrete structures forming a square. The concrete foundations will be protected against the action of ice by a low crib dam located about 100 ft. upstream and arranged so that the ice will pile up and break in small pieces before it can reach the tower foundations.

Into these four piers are to be anchored the four legs of the tower, which will be built of structural steel and will weigh about 400,000 lb. At the top, the towers widen out into a platform on which are mounted the supports for the three cables, which are to be of plow steel. These cable supports are all on the same elevation and placed in such a position as to keep the cables 50 ft. apart, to prevent them from swinging together in the long span. The cables are not anchored at the supports, but are brought down on the back of the towers to an anchor in the ground at some distance behind the towers. The supports, however, are designed to allow a certain amount of movement to the cables, due to the expansion caused by changes in temperature.

Insulation Offers Big Problem

In order to use the cables as electric conductors to carry current at 100,000 volts, it will be necessary to insert insulators in them between the ground and the supports on the towers. The magnitude of this problem is better understood when it is realized that these insulators are not only subjected to extreme electric tension, but also to a mechanical stress of above 150,000 lb. each. The arrangement of insulators must allow the replacement of any parts that may become damaged through electric failures, without interfering with the mechanical safety of the span. The insulator group will consist of an elaborate arrangement of porcelain units of a new type subjected to pressure only and held together by an iron frame.

It is expected that the work on this river crossing will start as soon as the river conditions will permit operations on the tower foundations; it is hoped to have the whole project completed by the end of the summer.

Huge Derrick Handles Steel Car Frames

The exceptionally large and powerful steel derrick illustrated in the accompanying view is installed on the dock of the Canadian Pacific Ry. at Vancouver, B. C., for use in loading and unloading ships and cars. It has a capacity of 50 tons and is shown handling the under-

DERRICK AT VANCOUVER HAS 50 TONS CAPACITY

frame of a 40-ft. steel car. The derrick has a 50-ft. mast with stiff-leg supports and carries a boom 100 ft. long. The mast has a 20-ft. bull-wheel for the cable used in slewing. The rigging consists of an 8-part hoisting tackle and a 20-part topping lift or luffing tackle. All motions are operated from a 75-hp. electric motor.

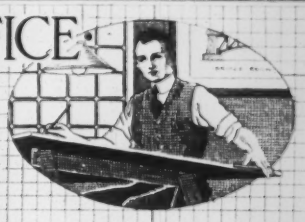
The members are of box section and of very heavy construction. The mast, boom and stiff-leg are all plated on back and front, while the side webs are partly of plate-girder type and partly of lattice construction. This derrick was designed and built by the Clyde Iron Works, Duluth, Minn.

Subway for Madrid

A subway for Madrid, Spain, is projected, and a concession has been granted under date of Jan. 12 to Don Miguel Otanendi for the construction and working, for a period of 90 years, of an underground electric-railway system to be known as the Metropolitano de Madrid Alfonso XIII. There will be four double-track lines and the system will be 8.7 miles long. The estimated cost is $6,000,000.

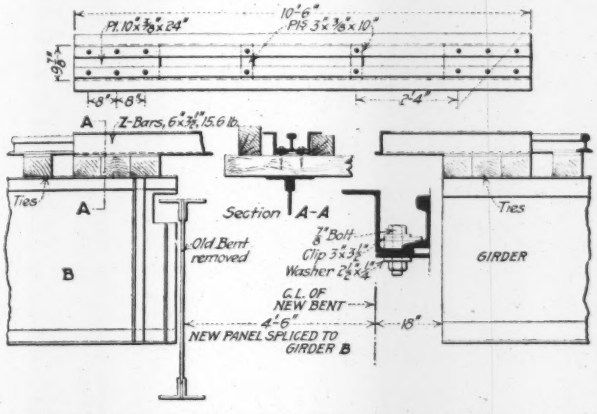
THE ENGINEER IN FIELD AND OFFICE

A DEPARTMENT
DEVOTED TO DETAILS OF THE DAY'S WORK



Temporary Stringers Carry Elevated Tracks

AN OPENING 4½ ft. wide in the structure of the Metropolitan Elevated Ry., at Chicago, was necessitated by changes in the bents and spans where the line crosses the new Union Station. One new bent was 4½ ft. from the old one, and the adjacent girder span had to be lengthened by splicing on an additional panel. Traffic could not be interrupted; and while the work was being



STRINGERS CARRYING TRACK RAILS ACROSS GAP IN ELEVATED RAILWAY DURING ALTERATIONS

done, each rail was carried across the gap in a stringer of trough section, the ends of the stringer resting on the track ties at each side of the opening.

Each stringer, as shown in the accompanying drawing, is 10½ ft. long and is composed of a pair of 6 x 3½-in. Z-bars connected by end plates 10 x 24 in. and by intermediate 3-in. straps riveted across the bottom flanges. These form a trough, or channel, about 9 in. wide and 6 in. deep, in which the rail is laid, with the sides of its base resting on the Z-bar flanges. The rail is secured by bolted clips, the head of the bolt being on the clip and the nut on the under side of the Z-bar. This work was done by the Brennan Construction Co., of Chicago, under the direction of C. M. Mock, chief engineer of the elevated railway.

Tracing Clearly Reproduced at Low Cost by This Simple Process

By CARLTON G. LUTTS
Pittsburgh, Penn.

A PROCESS for the reproduction of tracing should be of special interest to railroads, since they must prepare and furnish to the Interstate Commerce Commission complete maps and profiles of practically all their properties. These maps and profiles can be made only on tracing cloth and, unless some form of the lithographic process is used, must be drawn by hand. The work done by the method described below has been approved by the commission and is now employed by many concerns. The low cost for reproductions and the permanency of the drawings are two advantages possessed by this process.

Lithographic Principles Employed

This method employs the same basic principles as those which control the ordinary lithographic-stone process—the most important of these being that a greasy lithographic ink will not attach itself to a water-wet surface. The lithographic stone when properly prepared is deliquescent and thus presents a water-wet surface. In this new process the water is an ingredient of the compound.

In the following formula the first three components are necessary: Gelatin (must be of high grade), 100 parts by weight; water (from the tap), 400 parts by weight; ferrous sulphate (crystallized), 4 parts by weight; sulphuric acid (1 part concentrated acid, specific gravity 1.84, to 9 parts of water), 4 parts by weight.

A weak gelatin or a glue, if used, will greatly delay the time of setting and moreover contains adhesive materials which prevent the formation of a surface that will repel ink.

The ferrous sulphate should not have been exposed to the air for any length of time, nor show the presence of white spots, which consist principally of ferric sulphate. This will cause the ink to stick to the gelatin surface and is, in addition, a strong coagulator of gelatin solutions. The sulphuric acid may be omitted in the foregoing formula, and under no conditions should more than one-tenth of 1% of the concentrated acid be added, since an excess prevents the gelatination of the solution. Also it should be added in the dilute condition. It forms a solution that opposes the redissolving of the precipitated Turnbull's blue by any excess potassium ferricyanide. This will permit the use of a wider range of blueprint papers in the process.

Preparation Is Simple

The best procedure for mixing the material is as follows: 100 parts of the gelatin are weighed into a double-boiler kettle together with 300 parts by weight of water. When the gelatin has softened and absorbed the water, the additional 100 parts of water, with the ferrous sulphate and sulphuric acid in solution, are added and both are stirred together. The water in the outside kettle is now brought to the steaming point, and in the course of a few minutes the gelatin entirely dissolves.

The solution will contain considerable air mixed through it, but by turning off the heat and allowing the mixture to remain quiet for five minutes these bubbles will rise and may be dipped off with a spoon. Or the solution may be poured through a fine sieve into an iron pitcher, in which type of container it can be most readily handled—the sieve removing all undesirable matter and giving a perfect solution.

The warm fluid solution now in the iron pitcher is ready to be poured upon a surface of glass, zinc or any

other smooth material from which the gelatin compound may be rolled off readily after use. A table of approximately 5 x 10 ft. is the size generally preferred. To assure the spreading and covering of the surface when pouring the gelatin, the top of the table is usually constructed so that one side may be swung or raised higher than the other.

Watch Temperatures and Humidity

As soon as the surface of the table is well covered, the top is brought back again to its horizontal position, and the gelatin compound is allowed to harden. At ordinary room temperature 15 to 20 min. will be sufficient length of time to produce a surface which is elastic to the touch and on which a sheet of paper may be laid and removed without breaking the gelatin. To produce the best work, the temperature should be between 65° and 70°. At higher temperatures the time of gelatination will of course be lengthened. It is not well to have the temperature much lower than that mentioned, unless it is produced artificially; for with the humidity lower, as is usually the rule with low temperatures, the gelatin compound loses its surface water rapidly and is liable to develop an affinity for the ink.

The blueprint paper should be of the slow kind, well calendered, and should contain a less amount of salt than ordinary blueprint paper. The print should be made preferably on an electric machine, with which it is an easy matter to fix the right exposure. If underexposed, the background on reproduction will be smutty instead of clean, but the correct time of exposure can be readily determined experimentally.

Manipulation Is Rapid

The blueprint is taken off the machine and, without wetting, is laid or rolled face down on the surface of the gelatin. As fast as it is rolled down, it is pulled up from behind. The surface is now ready for inking. Suitable lithographic ink for this purpose can be supplied by the George H. Morrill Co., of Norwood, Mass. A small amount of ink is worked out upon a zinc inking plate with an ordinary 12-in. composition roller. The roller, properly inked, is rolled over the gelatin surface, the ink sticking readily to those portions of the surface which correspond to the inked portions of the original tracings. The surface should present a clear-cut inked drawing.

The tracing cloth is best formed over a roll and then rolled out over the gelatin surface. This method of laying down the cloth permits smooth reproduction and allows the cloth to be quickly drawn up again from behind. The duration of time that the cloth remains on the gelatin surface should be as short as possible, for, acting as an absorbent, it attracts the water from the surface and causes the latter finally to reach a condition where it repels the greasy lithographic ink with difficulty. If the background should take the ink, the trouble can usually be traced to wrong exposure of the blueprint paper or, in some instance, to a poor quality of ink.

The surface may again be inked, and as many as 50 copies can sometimes be printed before the design becomes faint. The available surface having been used, the gelatin composition may be rolled off, remelted and used again. After remelting six or seven times a chemical change has progressed to such an extent that the gelatin loses it power of gelatinizing, and a new batch should be made.

Should a small change be desirable in a large tracing that otherwise might necessitate redrawing the entire tracing, a blueprint from that tracing may have those parts cut out with a knife before it is laid down on the gelatin surface. Such changes as desired can then be drawn in after the reproduction is made. The process as outlined above is capable of the most varied application, has been successful in cutting costs in a number of large concerns and should, with the necessary attention to detail, find wide use.

Stream Discharge Easily Plotted with Novel Rating Curve

By FRANCIS H. KINGSBURY
Engineering Division, Massachusetts Department of Health

A QUICK and easy method has been developed for showing the variations in quantity of water passing a given point in a stream.

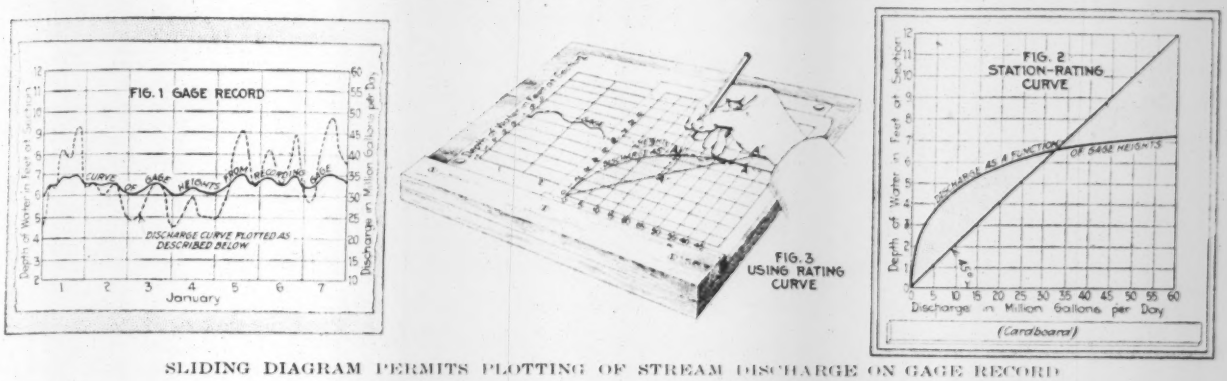
The common method of obtaining a continuous chronological record of the fluctuations of the height of water in rivers is by means of a gage with a clock and float attachment. A typical curve from such a recording gage is shown in Fig. 1. This curve is used in connection with what is known as a "station-rating curve" to determine the amounts of discharge. (This station-rating curve is made by plotting the discharge, determined from measurements of velocity and cross-section, as a function of the depth of water flowing.) The usual method of plotting a discharge curve is by reading from the station-rating curve the quantities corresponding to critical points on the curve of gage heights and then plotting these results against time on a separate sheet of cross-section paper.

The method herein described permits plotting the discharge curve on the same paper with the curve of gage heights. It also eliminates the time consumed in reading the gage heights, then referring to the station-rating curve to obtain the discharge, and finally plotting that value. This method presupposes the use of cross-section paper on the recording gage, as is usual with those gages which have a rectilinear rather than a circular movement of the recording pencil.

Plot Station-Rating Curve to Scale of Gage Record

It is necessary, first, to plot the station-rating curve with the same scale of heights as is found on the gage-height record. Then draw a straight line from the origin at an angle of 45° with the axes. Next, cut out with a sharp knife the sections lying between the station-rating curve and this 45° line. Finally, paste a piece of cardboard at the bottom of this curve, keeping the lower edge straight and parallel to the horizontal axes. Fig. 2 shows a station-rating curve thus prepared for use with the gage-height record in Fig. 1.

This station-rating curve is then superimposed on the gage-height record, as shown in Fig. 3, so that the horizontal lines representing the same gage height coincide. A scale of quantities precisely like that on the station-rating curve is then laid off on the vertical axis of the gage-height curve, the zero of this scale starting at the origin of the station-rating curve. To plot the discharge curve, all that is now necessary is to move the station-rating curve horizontally along a straight-edge until it



SLIDING DIAGRAM PERMITS PLOTTING OF STREAM DISCHARGE ON GAGE RECORD

intersects the curve of gage heights at any point A. Then follow the vertical from this point until it intersects the 45° line. This intersection A' is a point on the discharge curve.

Repeat this operation for all critical points A and then connect the points A' with a smooth, free-hand curve. This gives the discharge curve as in Fig. 1 plotted on the same paper with the gage-height record and corresponding to the time scale thereon. To determine the total discharge, planimeter the area under the discharge curve thus plotted.

That this method is correct is due to the selection and arrangement of the scales of height and quantity and to the fact that the ordinate of any point on a straight line passing through the origin and making an angle of 45° with the axes equals its abscissa. The operation of this method of plotting will be facilitated if the station-rating curve is made on tracing cloth and with no vertical or horizontal lines except the axes. The little extra time required in the preparation of the station-rating curve is many times recovered when plotting the discharge curve, especially if, as is often the case, the gage-height curve extends over a long period of time.

Piles in Soft Ground Spread; Pulled Back By Turnbuckles

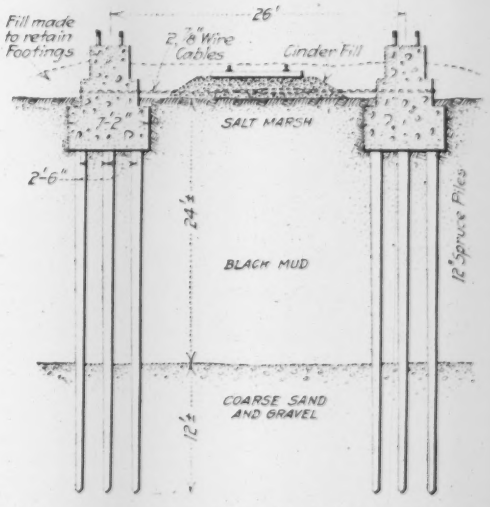
By A. P. ROSCOE
Civil Engineer, Ozone Park, Long Island

THE column footings for the three-track elevated railway along Stillwell Ave., Brooklyn, N. Y., were constructed across a swamp in which the mud varied in depth from 15 to 30 ft. The piers were supported on spruce piles 30 in. on centers, which were driven to refusal with a 2000-lb. drop hammer into the sand and gravel underlying the mud.

Over the greater part of this swamp there was an ash fill 6 or 8 ft. in depth, which had been in place some 6 years. This fill served to give lateral stability to the footings. At one point, however, near a creek, there was no fill on the original salt marsh. Here it was brought home forcibly to the engineers that piles driven in soft material, although able to support the load brought upon them, have little lateral strength, and that a structure supported on piles under such conditions is liable to injury if a horizontal force is brought to act on them.

The piers at this point are 7 ft. 2 in. by 9 ft. 8 in. in plan, supported by 12 piles each; they carry a load of 145 tons. The contractor laid a standard-gage track on a cinder fill about 2 ft. deep between the two lines of piers, and used a 50-ton locomotive and flat-cars to haul structural steel. The load of 35 tons per car axle which was thus brought to bear on the underlying mud forced it out laterally against the piers. It sprung the piles and spread the opposite piers apart 2½ in. in the bent in question.

In order to repair the damage, two ¾-in. wire cables with turnbuckles were passed around the piers. By drawing these up, it was possible to pull the piers back to



SPREADING FOOTINGS RESTORED BY TURNBUCKLES

correct position. An earth fill was made around the footings to retain them in their proper position, the cables being left in place as an additional precaution.

The sketch shows the resulting conditions. No further displacement has occurred.

Dense Wood Gives Nails High Values

Tests of the efficiency of various types of wooden joints were made by the Forest Products Laboratory, and about 3000 nail-pulling tests were completed on nails driven into twenty-five different species of American timber. While the data have not yet been analyzed, it appears that the holding power of nails has a definite relationship to the density of the wood, and that there is practically no difference in strength between a solid beam and a wooden beam of the same dimensions made of two planks nailed together.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

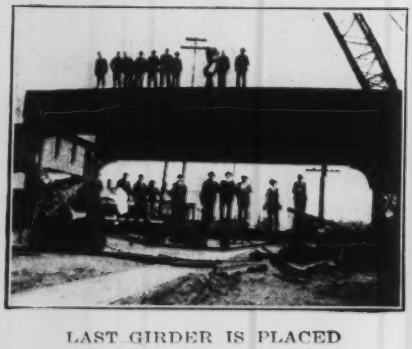
To Deepen Hell Gate Channel

On May 18 the War Department made public letters written by Secretaries Baker and Daniels urging the Rivers and Harbors Committee of the House to make provision for the deepening of the Hell Gate channel to 40 ft., as a war measure. In his letter to Chairman Small, Secretary Daniels stated:

"New York, being the center of commercial interests on the coast, and the great commercial activity and wealth extending particularly to the northward of this point, increases the probability of an engagement somewhere in the vicinity of the eastern end of the Long Island Sound. This also increases the desirability of having a deep channel through Hell Gate, in order to safely carry a vessel or vessels through that may have been injured in an engagement in the vicinity of Block Island.

St. Louis Municipal Bridge Approach Is Completed

Placing the last girder of the 3-mile east approach of the St. Louis Municipal Bridge over the Mississippi (at East St. Louis, Ill.) is shown in the accompanying view. This was accomplished May 1, and left only the timber deck and the tracks to be placed. The highway section of the bridge and approach was formally opened Jan. 20. The completion of the railway section finishes the main portion of the eastern approach, which has required the driving of 5000 concrete piles, the placing of 39,000 cu.yd. of concrete and the erection of 23,500 tons of steel. This



LAST GIRDER IS PLACED

extensive viaduct approach, including girder and truss spans, was described in "Engineering Record" of June 10, and in "Engineering News" of Dec. 14 and 28, 1916. The work has been done by city forces under a special organization in the Board of Public Service. E. R. Kinsey is president of the board; Clinton H. Fisk, chief engineer of construction; W. F. Collar, general superintendent in charge; Boller, Hodge & Baird, consulting engineers, and Brenneke & Fay, resident engineers.

Government To Contract for Thirty-Two Cities To House the New Army

Under Army Direction, Quarters for a Million Men Will Be Built of Wood and Have All Modern Sanitary Details

To house the new army of 1,000,000 men, 32 towns are to be erected at the mobilization camps, each capable of providing for about 22,000 soldiers—a division of infantry. Each will be a complete city in itself. The plans are all made and the locations are now being selected by the various department commanders. As soon as the camp sites are chosen the surveys will be made and contracts will be let. The construction work will be done by contract, under the supervision of army officers.

To direct this undertaking Col. I. W. Littell, of the Quartermaster General's Division, has been placed, by order of the Secretary of War, in general charge of cantonment construction. Colonel Littell has already begun organizing his forces for the work.

Large Amount of Lumber Required

Six hundred million feet of lumber will be required, and arrangements are being made to secure this in all parts of the country, preferably in the section where the camps will be located. Canvas is so scarce and high in price at the present time that the amount needed for tents cannot now be secured. Two sets of tents are required each year, and the wooden construction is not only more desirable, the officers say, but will actually cost less than it would to provide tents.

Each of the 32 cantonments contain about 2000 houses. These will include quarters for the men, officers' quarters, kitchens, mess halls, bathhouses, storehouses and all the various buildings needed for housing the troops and providing for the varied activities of a big camp. Most of the buildings will be long, one-story structures, with some two-story houses. They will be of plain construction, but will be of modern type, and the plans and sanitary arrangements will carry out the most approved methods. They are expected to be the best arranged, cleanest and most up-to-date barracks yet erected in this country or abroad.

Will Cover 720 Acres

Each town will cover about 720 acres, a little over a square mile, and this does not include the large area required for drill grounds at each camp.

The contractors who are to do the construction work will organize their own forces of carpenters, laborers, etc., but the building will be done under the direction of army officers. Several officers from the Quartermaster's Department, Government inspectors, timekeepers, foremen, engineers, plumbers, etc., will be stationed at each camp town, and Colonel Littell has already begun to arrange for the men required for this work.

In addition to the 32 camp towns, the Quartermaster's Department will erect groups of warehouses at points where army stores are to be concentrated. The exact number and location of these has not yet been determined, as they are to be erected to meet the needs of the army as they arise.

New York City's Industries To Be Enumerated

Under State Military Laws a Census of Resources Will Be Taken

E. P. Goodrich, recently appointed director of the state military census for New York City, has asked Alfred D. Flinn, deputy chief engineer of the New York City Board of Water-Supply, to organize a volunteer force from the engineers of the various branches of the profession in New York City for the purpose of taking an inventory of the military resources of New York City under the state military laws passed this year. It is estimated that 400 or more engineer canvassers will be needed, each giving two full days or more of his time. Letters giving further information and forwarding pledge cards will be sent to the engineers of New York City in the very near future. A preliminary enumeration has shown that in Greater New York there are about 3200 factories and mercantile establishments in which are employed 400,000 persons. This is more than 10% of the estimated total military population of the state. It is believed that this large group could be readily segregated and returns secured from them in their places of employment. Anyone desirous of helping, but who has not received notice, may communicate with Mr. Goodrich or Mr. Flinn, at 261 Broadway, Room 904.

Vermilion County Road Work Halted by Car Shortage

Because of the embargo placed on coal cars, work on the Vermilion County, Illinois, road system has been brought to a standstill, it being impossible to get consignments of gravel and crushed stone. About one-third of the $1,500,000 road system which is being built in this county was completed last year.

U. S. Shipping Board Announces Emergency Fleet Inspectors

The Emergency Fleet Corporation of the United States Shipping Board has districted the country for the purpose of constructing the munitions and food ships which the Government has undertaken to build as an aid in the conflict with the German campaign of sea-frightfulness. The inspectors having charge of the eight districts have "ample" power, according to General Goethals.

The names of the inspectors, their addresses and the territory covered by each follows: Charles N. Crowell, Merryville, La., Texas and the Mississippi River; Warren Johnson, Liverpool, London and Globe Building, New Orleans, La., east of the Mississippi River to Georgia; W. V. McGowan, United States Engineer Office, Jacksonville, Fla., Virginia to Florida (Atlantic and Gulf coasts); C. R. McDermott, Munsey Building, Washington, D. C., Chesapeake and Delaware, and Atlantic Coast from Philadelphia to Norfolk; Eads Johnson, 115 Broadway, New York, New Jersey (outside the Delaware River), New York and to east Massachusetts; W. H. Hand, Jr., New Bedford, Mass., east Massachusetts to Maine, inclusive; A. F. Pillsbury, 310 Sansome St., San Francisco, Calif., Pacific Coast; and John S. Blain (under Captain Pillsbury), Securities Building, Seattle, Wash., Seattle and vicinity.

Up to May 21, the following contracts have been let: Merril-Stevens Co., Jacksonville, Fla., 12 wooden and 4 steel ships; Los Angeles Shipbuilding and Dry Dock Co., Los Angeles, Calif., 8 steel ships; G. M. Standifer Construction Corporation, Portland, Ore., 10 wooden ships; Peninsular Shipbuilding Co., Portland, Ore., 4 wooden ships.

Another Engineer Reports on the Austin Dam

The Austin Dam across the Colorado River at Austin, Tex., the story of whose failure and the history of whose reconstruction have taken so much space in technical proceedings and the technical press, has been the subject of another investigation and report, this time by Edward Wegmann, consulting engineer, of New York. Mr. Wegmann's report was made last summer to local interests, but has only just now been made public.

Mr. Wegmann concludes, in brief, that the dam section is in itself of ample strength, but that the foundations require a cutoff wall some 30 ft. deep to solid rock; that the new hollow reinforced-concrete section is not strong enough to pass a possible flood, but that it can be made safe by adding intermediate buttresses; that the question of regulating the crest height can be best settled by the construction of a roller crest similar to that recently installed at Grand River, Colo., by the United States Reclamation Service, and that a downstream apron should be built, at a cost of $325,000.

Generous Response from Contractors

Offers Received from Companies Able To Start at Least $90,000,000 New Work Immediately in Reply to Inquiry, "Contractors, Come Forward!"

The announcement of "Engineering News-Record" on May 3 that it would collect and transmit to the proper authorities information regarding the resources of contractors who are ready to undertake construction work for the Government where it may be needed met with a most generous response. As fast as received, the information has been tabulated in a way to show the name and address of the contracting firm, the kind of work undertaken, the territory in which it operates, the amount of new work it could take on at present, the work it now has under way which ought not to be interfered with, whether or not the firm furnished a list of its equipment and whether or not it could supply an engineering unit for field service.

Where Lists Were Sent

As soon as completed, copies of this list were sent to the Chief of Engineers and the Quartermaster General, U. S. Army, and to the Chief of the Bureau of Yards and Docks, U. S. Navy. The original information, embodied in letters and reports from the contractors themselves, is being held at this office pending advice as to its disposition from Washington.

Although many of the largest contracting firms in the country are members of associations which have already volunteered their services to the Government, and are, of course, not repeated on this list, it appears that the contractors not previously registered with the Government, who have reported to this journal, have, combined, sufficient resources to initiate on short notice new work having a minimum value exceeding $90,000,000. More than half a hundred of them reported that they stood ready on short notice to organize work exceeding six figures in size.

Large Resources Represented

Many patriotic replies have been received, as well as many more expressing approval of the plan. A number of large firms have offered to convert all their resources to Government work. Several, in replying to the question of how much new work they could organize at present, answered, "Any amount wanted." As one of these companies recently initiated railway work running in nine figures in value for a foreign government, and several others are scarcely less powerful, the answer is not an idle boast.

In view of this large response, it is hoped that the object for which the inquiry was made will be attained. This was to furnish the Federal authorities with a more extended list of contractors who are willing to help with construction work at this time, so that in case the work required should threaten the construction labor supply or contracting resources of one section, others could immediately be drawn on. It is believed that, together with the large number of contractors who have already volunteered in several sections of the country, this list will afford an array of firms sufficiently large to carry out Government construction and to assist in the recruiting of engineer units.

Willamette River Bridge Project Now Ready

After a period of three years of misunderstanding between the two county courts having jurisdiction, a settlement has been effected and plans are being prepared for a steel bridge across the Willamette River at Salem, Ore. The history of the project is reviewed in the following notes received from Lewis W. Metzger, bridge engineer, Oregon State Highway Commission.

In 1914 the State Highway Department was requested to make surveys and prepare plans for a bridge at this location. Surveys and preliminary plans and estimates were made, and the matter rested for some time. Later on, it was decided to hold a competition and invite engineers to submit plans. Nothing satisfactory to the Board of Viewers being obtained, the State Highway Department in 1916 was requested to prepare plans for a low-level steel bridge with lift span. This was done, and an agitation was started for a high-level concrete bridge. Reports were later made indicating the impracticability of a concrete structure, due to its foundation conditions.

Mandamus Action Begun

The existing bridge being declared dangerous, it was closed to traffic and a ferry installed. Meantime, a bill was introduced in the legislature and passed, governing the construction of inter-county bridges where there is difficulty in the counties concerned coming to an agreement. About this time a mandamus action was brought by individuals against the two counties; but before a final hearing was had, one of the counties agreed to turn the design and construction over to the other and pay a certain sum upon the completion of the bridge. The State Highway Department was then requested to prepare plans and specifications for a steel bridge and supervise the construction.

Plans will be out early in May, and it is the intention to proceed at once with the construction.

There will be about 650 tons of steel, 100 ft. of reinforced-concrete approach, 250 ft. of fill approach, 750 ft. of first-class wooden approach. The bridge and approaches will have a 24-ft. roadway and a 5-ft. sidewalk on either side.

without serious consequences to work which should go forward in this country.

Acknowledgment is made of the valued assistance of contractors' organizations, patriotic bodies and others in various parts of the country who have helped in getting contractors to respond and have greatly facilitated the collection of the information requested. Thanks are also tendered to the large number of contractors who sent information direct to this journal without any other personal appeal than the request which appeared in its pages.

Detroit's 1917 Budget Raises City Engineer's Salary

The Detroit Board of Estimate in passing the budget for the year beginning July 1, 1917, has approved the city engineer's program for trunk sewers, totaling $8,264,500, with the understanding that not more than $4,000,000 in bonds will be sold during the year.

The budget shows an appreciable increase in compensation for responsible positions in the city engineer's offices, notable among these being the salary of the city engineer, which is increased from $4000 to $6000 per year.

Ontario Creates Highway System

The Provincial Highway bill passed by the Ontario legislature provides for the creation of a system of highways extending from the southwest boundary of Ontario to the Quebec boundary and connecting centers of population or other important terminal points. The roads assumed by the province are to be under the control of the Public Works and Highways Department—after being designated by the Government—and the maintenance, construction and alteration of the roads will be undertaken by the department. The cost will be distributed between the province and municipalities, the general underlying principle being that the township or local municipality should pay for a road sufficient for its local requirements only, the additional cost to be borne by the province with a special assessment on cities for roads adjacent to them.

Local municipalities will repay to the province 30% of the expenditure for roads within their limits, and each city will repay a like proportion of the expenditure on roads within the adjacent suburban area. By this apportionment the province bears 40% of the cost of roads within the suburban area surrounding each city, the city and township each contributing 30%. Outside of suburban districts the province bears 70% of the cost. The cost of surveys, machinery, plant and equipment and the general overhead and staff expenses will be borne entirely by the province. In the case of bridges having a clear span of 20 ft. or more, the municipality will be required to pay 60% of that part of the cost which would have been required for merely local purposes.

Military Census of Bureau of Mines Is Successful

The movement to collect military census statistics undertaken by the Bureau of Mines in coöperation with the American Institute of Mining Engineers and the American Chemical Society, as mentioned on page 116 of the issue of Apr. 12, has resulted in more than 10,000 chemists, metallurgists and mining engineers being enrolled to help in the war. The list, being tabulated for use of the Council of National Defense and the army and navy, includes several thousand men who are skilled in the making of explosives and others expert in the making of iron and steel. The efforts to mobilize technical facilities have brought many offers of complete laboratories, together with the working staffs, for research work. Among more than a score of laboratories placed at the disposal of the Government are those of Johns Hopkins University, Rockefeller Institute for Medical Research, New York, and the General Electric Co., Schenectady.

Tesla Receives Edison Medal

At the annual meeting of the American Institute of Electrical Engineers, which was held in the auditorium of the Engineering Societies Building, New York, May 18, at 8:30 p.m., the Edison medal was presented to Nikola Tesla for early original work in polyphase and high frequency electric currents. The work of Mr. Tesla has formed such an important contribution to the progress of electrical science and electrical engineering that it was highly fitting that the institute express its formal recognition in this manner.

Dr. A. E. Kennelly, chairman of the Edison Medal Committee, gave an address concerning the origin and purpose of the Edison medal, which was followed by an address by Charles A. Terry.

Western Pacific Ry. Absorbs Part of Smaller System

The California Railroad Commission has authorized the purchase by the Western Pacific Ry., for $700,000 cash, of those parts of the Nevada, California-Oregon Ry. extending from Reno, Nev., to Hackstaff, Calif., and from Plumas Junction to Davies Mill. Of these two lines the former is 64 miles long and the latter 39 miles. Of the proceeds the Nevada, California-Oregon Ry. is to use $606,000 to pay off present bonded indebtedness and $60,600 to pay interest, the balance to be returned to the company's treasury. The transfer will leave the company with 171 miles of narrow-gage track in California, Nevada and Oregon, with equipment necessary to its operation. The bonded indebtedness is $1,000,000, or at the rate of $5847 per mile.

Accident to Welland Canal Lock Causes Five Hours' Delay

The steel steamer "Natironco," up bound and light, struck and carried out the two headgates of lock No. 3, New Welland Canal, at 1:40 p.m. on May 3. The rear of the bank on the easterly side of lock No. 2 was partly washed away. Two spare gates were placed in position, and locking was resumed at 12:40 a.m. on May 4, having been interrupted 11 hours. Only one vessel was delayed, and for about five hours. The estimate of the cost of repairing the damages is $4000.

The cause of the accident was due to the snubbing wire getting caught in the compressor, and the vessel helper was unable to put the wire around the mooring post. When this was discovered, the "Natironco's" master signaled for the reverse; but instead the engineer put the engines ahead. The engines were finally reversed, but too late to avert collision with the gates.

Connell Quits as Philadelphia Highway Bureau Head

William H. Connell, chief of the Bureau of Highways of the Department of Public Works of Philadelphia, resigned on May 17 as the climax to a campaign to disrupt the engineering efficiency of the bureau which he had built up. Mr. Connell's resignation marked the success of the assault directed against the highway bureau by the political and street-cleaning interests, which have been heavily penalized and restricted recently. Since the assault on the highway bureau began, several striking developments have shown the trend of things. First, it was proposed that Mr. Connell be relieved of the supervision of street cleaning, garbage removal and allied public services. This was done.

New Conditions Found Intolerable

Mr. Connell resigned of his own volition, and both Mayor Smith and Director Datesman, of the Department of Public Works, expressed surprise. But in informed political circles it was common talk that Mr. Connell, by voluntarily resigning, clearly anticipated further hostile moves against him. As it was, his resignation was the only way out of the intolerable situation created when the new bureau of street cleaning was brought into being at the call of the mayor. To this bureau Mr. Connell was strongly opposed. He declared when it was proposed that the system he had organized was as efficient as possible and that the proposed system was illogical and retrogressive.

Then it was discovered that the ordinance providing for the new bureau legislated out of existence the $3000 post of assistant engineer held by James B. McCord, who was not favored by the political leaders. Then came the dismissal of Mrs. Edith W. Pierce, the city's first woman inspector of street cleaning.

On June 1 Mr. Connell will become connected with the firm of Day & Zimmerman, contractors and operating engineers, of Philadelphia.

Engineer Corps To Have Forestry Regiment

Woodsmen, Now Being Organized, Will Help in the Economic Use of French Timber

A "forestry regiment," made up of foresters, practical woodsmen, loggers, portable sawmill operators and others experienced in lumbering operations, for service in France, will, it is announced, be raised immediately. The Forest Service, at the request of the War Department, will prepare plans for the organization and equipment of the force and will aid in securing suitable men. The regiment will form a unit of the engineer corps now being recruited to be sent abroad as soon as it can be organized and equipped.

The organization of this regiment is the result of a suggestion made by the British Commission. Similar forces have been raised in Canada and are rendering valuable services. The object of the American forestry regiment, it is said, will be to convert available timber into material suitable for bridges, railroads, trenches and other construction work with the least possible waste. At the same time the cutting will be done under the supervision of technical experts in coöperation with the French foresters. In this way the permanent damage to the forests incident to furnishing the imperatively needed timber, it is hoped, will be kept as small as possible.

The regiment will be organized in units capable of handling all kinds of woods work and will include a number of portable sawmill outfits. It will be officered by trained foresters and expert lumbermen who are thoroughly familiar with producing and delivering lumber. It will carry complete equipment for all kinds of woods work. The classes of men desired comprise axmen, teamsters, tie cutters, millwrights, saw filers, sawyers, portable sawmill men, farriers, blacksmiths, lumberjacks, cooks and carpenters, as well as motorcycle and motor-truck operators.

War Postpones Million-Dollar Texas Bond Issue

Owing to the disturbed conditions existing as a result of the declaration of war, Walbarger County, Texas, has indefinitely postponed the election which was to be held May 29 on the question of issuing $1,000,000 road bonds. The proposal covered the building of 120 miles of concrete highways and will be placed before the people again after the cessation of war.

Wilmington To Enlarge Its Delaware River Port

Harbor Commission Appointed and Engineer Reports on Port Development

Wilmington, Del., which is on a tidewater branch of the Delaware River, with easy access to the open sea, is awakening to its possibilities as a port and has just taken the first step toward a harbor development. A board of harbor commissioners, consisting of three local business men serving at nominal pay, has been appointed by the mayor following legislative authorization of such a body.

IDEAL VIEW OF FUTURE HARBOR OF WILMINGTON, DEL.

Delaware River in foreground, with Christiania River leading up to city two miles away

Commission To Have Charge

The act provides that the commission shall have entire charge of the proposed river-front development and of all harbor property belonging to the city. The commission is required to adopt a plan for the improvement of the harbor and submit such plan to the City Council. If the Council approves the plan, it shall sell bonds to provide funds for the work. The board may submit further plans for extension from time to time. The city engineer is ex officio the engineer for the harbor board, but the board is authorized to employ additional engineers and is empowered to purchase or condemn river-front land and riparian rights and to construct wharves, piers, docks, warehouses and other structures, as well as belt and connecting line railroads. The board shall maintain and operate as public property all works constructed by it, operating under appropriations in the same manner as other city commissions.

As a preliminary step toward the port development the City Council, in coöperation with the Chamber of Commerce, retained John Meigs, lately Director of Wharves, Docks and Ferries, of Philadelphia, to make a survey of the harbor and to present a report on the possible development.

Wilmington is located at the confluence of Christiania River and Brandywine Creek, about two miles from Delaware River. The Delaware is now being dredged to a 35-ft. depth under Federal appropriations and the smaller rivers to 21 ft. up to the present wharves at Wilmington. Mr. Meigs considered three locations for a possible port, but emphasized the superiority of one—that is the area included south of the Christiania and west of the Delaware. This tract is on deep water, is easily accessible by land or water, and is reached by three trunk-line railways. It is shown in the left foreground of the view herewith.

Here it is proposed to build piers and wharves, connected directly to the railways, and, in the land behind, to develop a warehouse and manufacturing district. In addition the suggestion is made that Wilmington has here an ideal location for a free port where raw products may be brought in free of duty to be manufactured in bond and shipped again to foreign ports.

Mr. Meigs' scheme for future development is shown in the perspective view. It is hoped that the first work to be started will be on the piers on the left bank of the Christiania.

Cuyahoga Reports Exaggerated

The Cuyahoga County Commissioners deny any intention of holding up all road work until the end of the war or until economic conditions improve. However, it is true that in compliance with the law, which requires estimates to be made long in advance, and also requires various steps in connection with front-foot assessments, that many of the estimates that were made a year and two years ago are too low for present prices, and cannot be let because the law also requires that the bids shall not exceed the estimates by more than 10%. A fair mileage of the work that was intended to be done this year will have to suffer delay. The commissioners expect to have the principal main thoroughfares improved, having available funds to the amount of $1,600,000.

California Cement Companies Pleaded Guilty

Four California cement companies, through their officers, on Apr. 30 pleaded guilty in the United States District Court in Portland, Ore., to violating Federal anti-trust laws, and were fined $2500 each. Indictments are still pending against four other companies

Navy Abandons Liquidated Damages for Delays

Stock-Supply Contractors Will Not Be Penalized Except on Emergency Requisitions

It has become obvious that the clause in contracts covering liquidated damages for delayed deliveries has not operated to the advantage of the navy purchasing department. Contractors cannot understand, even under a liberal interpretation, why the Government should penalize them when it suffers no loss resulting from the delay in delivery. There has sprung up an opinion in the commercial world that there is so much red tape involved in navy business that it is not attractive to manufacturers and that the work involved in making claims for refunds, even in cases where refund is warranted, is not worth the return. The collection of liquidated damages involves a greater amount of clerical work than is compensated for by the amount derived from it. The navy loses the goodwill of many responsible concerns, and its methods are always under criticism because they depart from commercial methods.

Still in Force for Certain Materials

Effective immediately, all contracts made by the Bureau of Supplies and Accounts of the Navy Department, which cover materials for stock requirements, will not be subject to the clause providing for liquidated damages for delay. There remains, however, outside of the purchases for stock, many contracts covering materials, which, due to special needs at the moment, must embody some provision regarding damages for delay. To that end the clause as now existing will continue to be applied to purchasers of machinery and equipment for ships under construction in navy yards, of special apparatus, machine tools or yard equipment, radio apparatus, airplane material and special ordnance material. Until the proposal and contract forms are modified, proposals will specifically state that "the clause covering liquidated damages does not apply hereto."

Plans for New Shipbuilding Plant at San Francisco

Further details have just been announced with regard to the Union Iron Works shipbuilding plant at San Francisco. The plans include the use of the 100-acre tract recently purchased on the Oakland estuary, where an immediate expenditure of $5,000,000 is contemplated, with an ultimate expansion to a $20,000,000 investment. The work now proposed includes the dredging of a canal 30 ft. deep and 300 ft. wide from the mouth of the estuary to Eagle Ave., a distance of about half a mile; dredging and filling of marsh land; the construction of four shipbuilding berths from which 1000-ft. ships can be launched; and the erection of warehouses, machine shops and other structures.

Going Value Disallowed in California Decision

Going-concern value was disallowed in a decision handed down May 8 by the California Supreme Court in a case involving the electric rates of the San Joaquin Light and Power Corporation. The court thus sustained the State Railroad Commission. The commission is also upheld in denying the company a greater allowance for water rights than the moneys actually expended by the corporation.

The burden of the conclusions by the court is that when a property is valued by the commission in a rate case as a "going concern" or business actually in operation no additional allowance need be made for "going-concern" value. Where a public utility has repaid itself out of its earnings for development expenditures no allowance need be made by the commission for such development expense.

Another point made by the decision is that a return of only 6½% on fair value would not be confiscatory. The corporation had contended for 8% on the higher valuation claimed by it—this including $650,000 for water rights and $1,651,021 for "going concern" in a total of $10,054,540.

Regiment of Engineers Completed

Though its entire complement of 1068 men and 37 officers has been recruited, enlistments in the Fifth Engineer Reserve Regiment of Pittsburgh, organized for early service in France, will be continued for several days, it was announced this week, in order to have men to refill the ranks after rejection of those who fail to pass Federal physical examinations.

Issues Specification Form for Federal-Aid Roads

The Secretary of Agriculture has issued an order, dated Apr. 28, 1917, prescribing certain standards governing the form and arrangement of plans, specifications and estimates for all Federal-aid projects for which statements are submitted after Sept. 30, 1917. These standards were formulated by the Office of Public Roads and Rural Engineering in conjunction with a committee of the Association of State Highway Officials, consisting of Messrs. Euler, Dean and Marr, state highway engineers of Pennsylvania, Massachusetts and Illinois respectively.

The standards, which are quite bulky, may be obtained from the Office of Public Roads in Washington. They consist of an explicit outline of the general arrangement and form of the plans, specifications, estimates, bonds, contracts, etc., which constitute the documentary part of roadbuilding. As after next September it is required that all roadwork for which Federal aid is requested must be prepared in accordance with these standards, it is probable that their adoption will be general.

Vehicle Tunnel Under Hudson Gets New Lease of Life

Essex County, N. J., Appropriates Money—State Law's Demand Is Now Complied with

Prospects of a vehicular traffic tunnel between Jersey City and New York are very much brighter as the result of the action of the Essex County Board of Freeholders last week in appropriating $10,000 toward the establishment and maintenance of a permanent New Jersey Bridge and Tunnel Commission to act in conjunction with a similar commission in New York State.

Essex County is the third New Jersey county to make such an appropriation, and Governor Edge can now proceed with the appointment of commissioners. Hudson and Bergen County Freeholders made appropriations for a tunnel commission some months ago, but the Essex County board delayed action until last week. Under the Bridge and Tunnel Act it was necessary for three counties to join hands before the Governor could appoint a permanent state commission.

This project received very full treatment in the "Engineering News-Record" of Apr. 19, p. 132. The traffic studies made by the board of engineers of the Public Service Corporation of New Jersey show that the expenditure of $6,899,000 would be justified.

Rhode Island Road Bids $8000 a Mile Above Estimates

It will cost the State of Rhode Island $305,876.75 to build 13 miles of highway, which is at the rate of $23,528 per mile, according to bids opened by the State Board of Public Roads May 9. These figures represent the lowest bids and do not include the asphalt for the work.

The price is much higher than the estimates of the board at the close of last year, when what appeared then to be a reasonable allowance was made for the increased cost of materials. The board estimated that it would cost about $15,000 per mile, and the figures received exceed that estimate by more than $8000 per mile.

The bids are all for bituminous construction, excepting one mile in East Providence, which is to be cement concrete. It is stated that if these prices prevail, the state will have to curtail its road-building program materially.

Minneapolis To Check Up Car Line Valuation

The Minneapolis City Council committee on street railways and extensions recently authorized the employment of Charles L. Pillsbury to make a preliminary report on the valuation of the street railway company. According to his proposal Mr. Pillsbury will begin work June 1 and will complete his report within a month or six weeks. His report will be in the nature of a checking of the report of F. W. Cappelen, city engineer.

The Nine Engineer Regiments

The four officers whose photographs appear on this page, together with the five whose pictures were published in last week's "Engineering News-Record," will command the nine engineer regiments which are now being recruited for service abroad. The troops, it is stated, will be used chiefly for railway construction, maintenance and operation and for road building. Men enlisting in these units do so for the term of the war only and are not subject to transfer to other units.

Photograph at lower right copyrighted by International Film Service.

Miami Conservancy Appraisal Is Now Complete

An important step forward in the flood protection of the Miami River Valley in Ohio was made on May 9, when the complete appraisement roll of the Miami River Conservancy District was filed in the Conservancy Court. This roll represents the work of 21 months, during which time the appraisers have not only had to estimate the value of all the property in the district, but also to determine the probable benefit of the improvement to the areas within the territory which might be flooded under extreme present conditions.

The total tax levy is $27,700,000, which allows a comfortable margin for the execution of the entire flood protection of the valley, estimated at about $24,000,000. The levy is to be brought into court on June 18, at which time any objections to the plan or to the levy will be considered. As soon thereafter as may be, provided the court approves the roll, bonds to the amount of $25,000,000 will be put on the market. Following the sale of these bonds the construction will be put under way. At present it is hoped that construction can be started by next fall, a satisfactory protection against flood achieved in two years and the whole work as planned completed in three years.

Road Engineers To Be Examined

The Tennessee State Highway Department has announced an examination for assistant highway engineers to be held in the senate chamber in Nashville at 8:30, Tuesday morning, May 29. This examination is in conformity with the provisions of the recent law that requires employees of the department to pass a satisfactory examination before the dean of engineering of the University of Tennessee, the state geologist and the state highway engineer. These three positions are held respectively by Prof. Charles E. Ferris, Dr. A. H. Purdue and A. M. Nelson.

Michigan Engineering Students Form Regiment

Starting this week, a complete regiment of 1200 students of the Engineering College, University of Michigan, will drill two hours a day, twice a week, under the command of Maj. C. E. Wilson.

A course known as the elements of military engineering, instituted immediately after the Easter vacation, is now in full swing. It is open only to seniors and juniors, and consists of classroom and field work in such subjects as road construction and maintenance, temporary and permanent military structures, camp sanitation, personal hygiene, field mapping, and trenches and fortifications.

Special intensified courses are being given to students qualified to take them in telegraphy, signaling, transportation, munition inspection and the like.

Personal Notes

A. C. Clarke, chief of the facilities bureau of the commercial development department, Baltimore & Ohio R.R., has been appointed assistant engineer of surveys, succeeding H. A. Lane, recently promoted to chief engineer, Philadelphia.

Forest A. Wells, formerly with the valuation departments of the Boston & Maine R.R. and then the Pennsylvania Lines West of Pittsburgh, is now with the Union Pacific at Omaha, Neb., in a similar capacity.

Lyman E. Bishop is acting as resident engineer for Charles W. Comstock, who is consulting engineer for the earth dam being constructed across the Costilla River at Jaroso, Colo., for the Costilla Estates Development Co. Thomas H. Olds is principal assistant engineer in this work and C. H. W. Smith is assistant engineer.

Henry S. Kerbaugh has discontinued his connection with the Kerbaugh-Empire Co. and has opened offices in the Hudson Terminal Building, New York City, continuing in the general contracting business.

C. Dwight Curtiss has resigned as assistant engineer in charge of tests and investigations with the Iowa Highway Commission and is now in charge of the laboratory of the J. B. McCrary Co. at Anderson, South Carolina.

J. A. Cushman has resigned as assistant sanitary inspector of the metropolitan water and sewerage board of Boston to accept the position as assistant engineer with the Turner Falls Power and Electric Co., of Springfield, Massachusetts.

Ira R. Browning has been appointed state road engineer of Utah, to succeed E. R. Morgan, resigned.

W. E. Baldry, of Dodge City, Kan., has succeeded A. R. Young as city engineer of Topeka, Kansas.

A. B. Rutherford has resigned from the Republic Construction Co., of Mansfield, Ohio, and is now superintendent for the A. J. Smith Construction Co., Detroit.

A. L. Grandy, chief engineer of the Pere Marquette, with office at Detroit, Mich., has been appointed assistant general manager, with the same headquarters. Mr. Grandy was appointed chief engineer of this company in January, 1913, prior to which he had been division engineer, Saginaw, Michigan.

Job Tuthill, of the engineering department of the Michigan Central, with office at Detroit, Mich., has been appointed chief engineer of the Pere Marquette at Detroit, succeeding A. L. Grandy, promoted.

L. G. Harris, acting division engineer of the Atchison, Topeka & Santa Fé at La Junta, Colo., has been appointed division engineer, with office at San Marcial, N. M., succeeding W. J. Lan[illegible] resigned.

Among the 80 residents of Seattle commissioned or recommended for commissions in the Engineer Officers' Reserve Corps of the army, now being raised by Lieut. Col. J. B. Cavanaugh, are six county or city employees, as follows: E. French Chase (captain), engineer of the street and sewer department, formerly in the city engineering department; O. A. Piper (captain), district engineer, city engineering department, formerly assistant engineer in employ of the United States Government; T. R. Beeman (captain), engineer in charge of county bond road construction, formerly assistant engineer for the Southern Pacific Ry. and district engineer for the Chicago & Milwaukee Ry.; H. L. McGillis (captain), engineer for city park department; D. H. Evans (lieutenant), assistant county bridge engineer; W. L. Hoffidetz (lieutenant), inspector of materials in the city engineeering department.

J. H. Giles has been appointed city engineer of Pocatello, Idaho.

Guy Molyneux has been appointed city engineer of Sandpoint, Idaho.

Robert Bridges, president of the Seattle Port Commission, who recently resigned his position, has withdrawn his resignation and will continue in his former office.

R. N. Priest, construction engineer on the Atchison, Topeka & Santa Fe Ry., has been appointed division engineer of that road at Kansas City, Kan., succeeding H. J. Moore. **L. G. Harris**, acting division engineer at La Junta, Colo., has been appointed division engineer at that point, succeeding Claude Betson. **L. M. Townsend**, acting division engineer at Dodge City, Kan., has been appointed division engineer, with same headquarters, to succeed L. C. Graves. **Irving Anderson**, office engineer at Chicago, has been appointed acting division engineer at Marceline, Mo., succeeding W. C. Baisinger.

W. H. Seagrave and **W. E. Dunkle** have formed the firm of W. H. Seagrave, consulting mining engineers, opening offices at 1505 L. C. Smith Building, Seattle. Mr. Seagrave has been manager of the Kennicott mine, which is the world's greatest producer of high-grade copper ore, and Mr. Dunkle until recently was the field geologist and traveling representative in the Northwest and Alaska of the Alaska Syndicate.

Lieut. Col. James B. Cavanaugh, United States Engineer Corps, who has been in charge of the construction of the Lake Washington Canal locks and other Government engineering and fortification works in the Seattle district since 1911, has been instructed by the War Department to form a regiment to be known as the Eighth Reserve Engineer Regiment. The regiment will be recruited from the Pacific Coast states and will be commanded by Lieutenant Colonel Cavanaugh, who will be succeeded in Seattle by Maj. Elliott J. Dent.

United States Engineer Corps, now in charge of the Portland district.

H. B. Wells has been appointed assistant superintendent of construction for the Alaskan Engineering Commission, Matanuska District of the Alaska Railways.

Mack Galbreath is on leave of absence from the Office of Public Roads and has charge of the bond issue road work in Trigg County for the Kentucky State Highway Commission.

E. C. L. Wagner has recently become associated, as consulting engineer, with Campbell Brothers, contractors and builders, Kansas City, Mo., having previously been superintendent and engineer for the Midwest Construction Company.

Charles E. Ashcroft, for the past nine years junior engineer, United States Engineer Department, Pittsburgh district, is now with the Foundation Co. as superintendent in charge of the construction of foundations for the H. C. Frick Coke Company.

O. E. Noble, formerly city engineer of Manhattan, Kan., has been appointed highway engineer for Riley County, Kansas, in compliance with the new roads law.

J. E. Bernhardt has been appointed bridge engineer of the Chicago & Eastern Illinois R.R., with office at Chicago, Illinois.

Arthur C. Brandt is at present located in Springfield, Mass., in charge of the erection of the Chapin National Bank Building, for the architects, Mowbray & Uffinger, New York City.

Charles H. Lee, during his absence as an engineer officer of the Officers' Reserve Corps, has left his consulting practice to the direction of W. K. Barnard, of Leeds & Barnard, consulting engineers, Los Angeles, California.

Edward N. Brown, who has been elected chairman of the board of directors of the recently reorganized Pere Marquette, is an engineer by training, entering railway service as a rodman on the North Eastern Railway of Georgia in 1878. After serving as division engineer and resident engineer on the Central of Georgia he went to Mexico in July, 1887, where he became engineer in charge of the construction of the line of the Mexican National, between Saltillo and San Luis Potosi. In September, 1888, he was appointed division superintendent, with headquarters at the same point. He was made vice president and general manager in March, 1902, and president of the National Railroad of Mexico in April, 1904. In 1909 he became president of the National Railways of Mexico, which position he held until October, 1914, when he resigned because of the unsettled conditions in that country.

William D. Shannon, who has been for two years in the track department of the Stone & Webster Engineering Corporation, in charge of track construction work for the Puget Sound Traction, Light and Power Co., of Seattle, Wash., is now connected wtih the hydro-electric plants of the Puget Sound country as construction engineer.

Frank H. Alfred, who has been elected president of the reorganized Pere Marquette, began railway work as a rodman on the construction of the Columbus, Lima & Milwaukee in 1887. After being employed on the Norfolk & Western, the Cleveland, Akron & Columbus and the Wheeling & Lake Erie, he became assistant engineer of the Pere Marquette in 1900. He was made chief engineer in October, 1902, resigning on Oct. 1, 1905, to become manager of the Canadian White Co., Ltd. In 1908 he returned to railway service, as assistant to the president of the Cincinnati, Hamilton & Dayton. In April, 1912, he was appointed assistant general manager of the Pere Marquette, being made general manager later and then chief executive officer for the receivers, which position he held at the time of his recent promotion.

Cyril H. Wakefield, formerly on valuation work with the Norfolk & Western Ry., is now assistant to George H. Erickson, consulting engineer, Swea City, Iowa.

Mathew J. Butler, managing director of Armstrong Whitworth of Canada, recently received the degree of LL.D. from St. Francis Xavier University, Antigonish, Nova Scotia.

Maj. George B. Pillsbury, Corps of Engineers, U. S. A., has been transferred from Los Angeles to duty at the Presidio, San Francisco.

A. M. Croxson, formerly in the construction division of the Bureau of Public Works, Philippine Islands, has recently formed a partnership with William Kirk, specializing in steel and concrete structures, with offices in the Securities Building, Seattle, Washington.

Frederick McQ. Falck has been appointed assistant general manager of the Philadelphia & Reading, with headquarters at Reading, Penn. He began railway work with the Philadelphia & Reading on June 1, 1898, and was appointed assistant supervisor at Shamokin, Penn., in August of that year, being promoted through the grade of supervisor to division engineer in May, 1903. In October, 1910, he was appointed assistant superintendent of the Wilmington and Columbus division at Reading, since which time he has been in the operating department.

Frank L. Raschig, who has been in charge of the Division of Structures, Engineering Department, City of Cincinnati, has been appointed principal assistant engineer by Frank S. Krug, chief engineer of the Rapid Transit Commission. To assist Mr. Raschig in preparing the plans for the rapid transit loop J. R. Biedinger, F. E. McMinn and Paul R. Kirstein have been appointed designing engineers.

James R. Stewart, of Cincinnati, has been selected by the Rapid Transit Commission of Cincinnati as a consulting engineer.

Obituary

Edwin J. Haddock, who died Apr. 11 as a result of an automobile accident, was born in Mount Vernon, N. Y., in 1868. Completing his early training with seven years spent under the immediate direction of Thomas A. Edison in New Jersey, Mr. Haddock was later chief draftsman of the Robins Conveying Belt Co., of New York; chief engineer of the Jeffrey Manufacturing Co., Columbus, Ohio, and chief draftsman of the Tennessee Coal, Iron and Railroad Co. in Birmingham, Ala. Engaged in private practice in Milwaukee, Wis., he built numerous stone-crushing plants in that region. At the time of his death he was chief engineer of the Edgewater Steel Co., of Pittsburgh.

John W. Dix, assistant general manager of sales and structural engineer in charge of plates, shapes and other structural materials for the Carnegie Steel Co., died in Atlantic City on Apr. 28, at 43 years of age. He had been in the employ of the Carnegie Company since 1900. Mr. Dix became also several years ago president of the Central Steel Co., Massillon, Ohio. He began his business career as draftsman with the old Keystone Bridge Co.

Business Notes

Charles D. Watson, contracting engineer, of Philadelphia and Cleveland, has announced that he will hereafter conduct his business under the name of the Pre-Cast Concrete Co., with main offices in Cleveland.

The Steel-Lock Concrete Construction Co., of Pittsburgh, recently established Western headquarters in the New York Building, Seattle, with Martin Korstad in charge.

The Hesse-Martin Iron Works, Portland, Ore., announces that it will shortly place on the market a line of marine auxiliaries designed under the direction of C. H. Watson, formerly of the engineering department of the Bath Iron Works, Ltd., Bath, Maine.

The John H. McGowan Co., builder of water-works pumping engines, has secured the services of George W. Neff, formerly of the Platt Iron Works Co., as New York representative, with offices at Room 1567, 50 Church Street.

Leon H. Johnson, formerly with Struthers-Wells Co., Warren, Penn., has entered the employ of the Anderson Foundry and Machine Works, Anderson, Indiana.

James P. Karr has been appointed manager of the American Steel Dredge Co., Fort Wayne, Ind., to succeed **J. D. Rausch,** now connected with the Wayne Oil and Pump Co. Mr. Karr was con-

nected with the original design of the company's steel dredge and was president of the company until about three years ago.

Charles S. Vought, formerly connected with the Cambria Steel Co., and for the past year in the employ of the American Steel Export Co., New York City, has been made assistant general manager of sales of that company.

E. C. Bauer, of the sales department of the American Manganese Steel Co., Chicago, has been appointed to the office of assistant to vice president of the company.

C. L. Vickers, for many years a member of the firm of the Perine Machinery Co., Seattle, Wash., has disposed of his interests in that firm to engage in business under the name of Vickers, Son & Co., handling hydraulic and pumping machinery. The other members of the firm are C. B. Vickers and N. A. Robinson, both men of long experience in the machinery game. Offices of the company are located at 528 First Ave., S., Seattle.

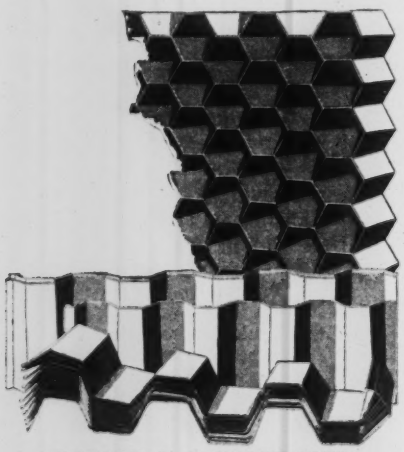
S. G. Matthews & Co., engineer and contractor, has moved its office and shop from 916 North Ninth St. to 20th and Clearfield Sts., Philadelphia.

The Asbestos Protected Metal Co., of Pittsburgh, announces the appointment of Stanley L. Rau as subagent for Grand Rapids and vicinity, with offices in the Powers Theater Building.

Appliances and Materials

Interlocking Steel Shelving Makes Hexagonal Cells

A unique system of shelving has been devised by Herman Soellner, 309 East 56th St., New York City, possessing great flexibility of arrangement and ease of setting up or knocking down. The shelves are made of strips of bent



HEXAGONAL COMPARTMENTS ECONOMIZE SPACE

steel which slide together at tongue-and-groove joints and lock in position by the engagement of raised points. No tools are required. The resulting compartments are hexagonal in section and for many services give a maximum utilization of wall space.

All-Steel Fire-Doors of Corrugated Sheets

An approved fire-door made of two sheets of galvanized corrugated steel or iron and lined with asbestos paper is being made by the Merchant & Evans Co., of Philadelphia. It carries the trade name "Almetl" and is claimed to be not only lighter and stronger, but also more fire resistant and durable than the three-ply tin-clad wood doors.

Gasoline Railway-Inspection Car

A novel design of inspection car is shown in the accompanying illustration, the car being one built recently for the use of the officers of the Midland Valley R.R., in Oklahoma, when making inspection or other special trips. It is of steel construction throughout, with side doors, large windows and flat roof. It is provided with both chairs and long seats, and will accommodate nine passengers, although there is room for additional seats if required. Electric lamps are used for the interior lighting and for the headlight and marker lamps. The inside dimensions are 12 ft. 3 in. in length, 5 ft. 4 in. in width and 5 ft. 3 in. in height. The body is set very low, so that the total height above top of rail is only 7 ft. 1 in. This, with the large windows, facilitates inspection.

At the forward end is placed a 30-hp. four-cylinder engine of the automobile type, with its radiator fitted to an opening in the front of the car. The engine has a direct drive to the rear axle, and the car can be run at full speed in either direction. The maximum speed

DRIVEN BY 30-HP. GASOLINE ENGINE

is about 30 miles an hour. The car is mounted on four wheels and has a pilot, or cow-catcher, at each end. Its weight is about 5300 lb. This inspection car was designed and built by George P. Nichols & Brother, of Chicago.

Service to Contractor Keynote of Sales Convention

Service to the contractor was the keynote of the sales representatives' convention held by the Lakewood Engineering Co. at its plant in Cleveland on Friday and Saturday of last week. The heads of the sales and of the factory departments each had an opportunity to show how his division was coöperating to make a better product and to render prompt and efficient service to the representative, and through him to the contractor. Special time was assigned for the discussion of the features of the main lines of the company —contractor's plant, industrial cars, electric locomotives and clam shells. The whole subject of the proper type of paving equipment was also gone into, announcement being made at the same time that one of the members of the organization had been assigned to spend the better part of this year in a careful study of paving methods, to the end that improved equipment might be designed.

To Avoid Error in Ordering Parts

Among the topics discussed with keen interest was the method of arranging for the ordering of repair parts so that the contractor would get what he wanted and get it quickly. It developed that if in ordering, the customer gave not only the number cast or stamped on the part and the type of equipment, but the serial number of the machine, errors in supplying parts would be eliminated. It was further urged that every contractor when shipping equipment to a job should send to the time or material clerk a part list of every piece of equipment. Parts could then be ordered correctly right from the job and errors and delays between the job and the home office be avoided.

The convention closed with a dinner at the Cleveland Athletic Club on Saturday. It was made the occasion of giving the visitors in attendance an insight into the history of the Lakewood Engineering Co. Not the least interesting feature was the light it threw upon the company's method of developing men and on the thoroughness with which the company's ideal—service to the user of Lakewood equipment—pervades every part of the organization.

The meeting was one of a series of sales conventions being held by the company, the purpose being to bring together a few representatives at frequent intervals rather than have general sales conventions once or twice a year.

Among the agents present or represented were the Harold L. Bond Co., Boston; the C. R. Dodge & Co., New York.; F. H. Robinson, Pittsburgh; Geo. B. Curd, Cincinnati; Geo. T. Wallace, Detroit, and H. D. Hutcheson, Rochester, N. Y.

The general sessions were presided over by Charles F. Lang, president, and Roy G. Owens, sales manager, contractor's equipment.